SCIENCE ABSTRACTS.

Section A.—PHYSICS.

SEPTEMBER, 1928.

GENERAL PHYSICS.

2250. Experimental Study of the Flow of Water in Pipes of Rectangular Section. S. J. Davies and C. M. White. *Roy. Soc., Proc.* 119. *pp.* 92–107, *May* 1, 1928.

The "pipe" was between brass blocks with surfaces scraped plane and separated by foil shims at the ends, the sides being closed by thin plates with a rubber insertion to make a watertight joint. The range of distance between the surfaces was 0·015-0·068 cm., the width being 2·54 cm. throughout. The blocks are drilled for inlet and outlet and for manometer connections. For small Reynolds numbers viscous flow is obtained, and the resistance agrees with that for tubes, provided that the hydraulic mean depth is used as the length in the Reynolds number formula. With increasing depth, departure from laminar flow occurs at lower Reynolds numbers, which points to a departure from similarity of flow. This was traced to the effect of the "entrant length," and the conclusion is reached that for values of the Reynolds number less than 140 eddies cannot be transmitted to, or exist in, the channel. This number is also in general agreement with Orr's calculated "critical velocity." It was also shown that roughness, amounting to 2 % of the depth, produced no measurable effects. W. G. B.

2251. Mesomorphic States. G. Mayr. *N. Cimento*, 5. (*Rivista*). *pp.* 25–55, *Feb.*, 1928.

The phenomena of liquid crystals and of anisotropic properties exhibited by liquids under the influence of velocity gradient, electrostatic stress or a magnetic field are considered to be evidence of a distinct state between the solid and the liquid. A long survey with references is made of the experimental data and papers on these subjects, and the structure of the systems exhibiting these peculiar properties is discussed. A. Wh.

2252. Enantiotropy and Monotropy. Part I. N. Nagasako. *Chem. Soc. Japan, Bull.* 3. *pp.* 90–95, *April*, 1928.

Lehmann first classified the two distinct behaviours of dimorphism in which transitions are of reversible and irreversible natures as enantiotropy and monotropy. Ostwald and others gave interpretations later on the basis of the phase theory, but clear definitions, which have not been given hitherto, are now proposed so as to be consistent with all the experimental cases in the wide range of *p*T diagrams. The expressions not only serve to express the absolute stability, but also the mutual stability, of the two modifications in one component. The necessary thermodynamic relations are also considered, and cases of pseudo-equilibrium are discussed. As a result various theories on enantiotropy and monotropy are brought into conformity. H. H. Ho.

2253. X-Rays and Enantiomorphism. A. Hettich. *Zeits. f. Phys.* 48. 9–10. *pp.* 614–615, 1928.

A short note on the distinguishing of right- and left-handed forms by means of X-ray methods. W. H. Ge.

2254. Crystal Structure of Lithium Iodide Trihydrate. S. B. Hendricks. *Am. J. Sci.* 15. *pp.* 403–409, *May*, 1928.

Laue and spectrum photographs were employed. The unit of structure is hexagonal and contains two $LiI . 3H_2O$ molecules, $d_{100} = 7\cdot45$ Å. and $d_{001} = 5\cdot45$ Å.; space group, $6e\text{-}_4$; atomic positions, I at (*b*) $\frac{1}{3}\frac{2}{3}u$; $\frac{2}{3}, \frac{1}{3}u + \frac{1}{2}$ (with $u = 0$); Li at (*b*) $\frac{1}{3}\frac{2}{3}u$; $\frac{2}{3}, \frac{1}{3}, u + \frac{1}{2}$; O at (*c*) $u\bar{u}v$; $2\bar{u}, \bar{u}, v$; $u, 2u, v$; $\bar{u}, u, v + \frac{1}{2}$; $2u, u, v + \frac{1}{2}$; $\bar{u}, 2\bar{u}, v + \frac{1}{2}$. It was impossible to determine the values of the parameters. A diagram illustrates the relative positions of the I, Li and O atoms in the unit structure; the atomic configuration is the same as that of the triethyl ammonium halides. H. N. A.

2255. Crystal Structure of Alums. L. Vegard and E. Esp. *Ann. d. Physik*, 85. 8. *pp.* 1152–1164, *May* 24, 1928.

Powder photographs of four alums, NH_4Al–, KAl–, NH_4Fe– and $KCr\text{–}(SO_4)_2 . 12H_2O$, give the edge of the unit cubes 12·11, 12·08, 12·165 and 12·03 Å. respectively. Various speculations on the structure are discussed. W. H. Ge.

2256. Intensity of Reflected X-Rays and the Distribution of Electrons in Crystals. G. E. M. Jauncey and W. D. Claus. *Phys. Rev.* 31. *pp.* 717–727, *May*, 1928.

Refers to the suggestion of Williams and of Jauncey that the intensity of reflected X-rays is less than that predicted by the classical theory because of modified scattering due to the Compton effect. Havighurst has criticised this suggestion, and the authors show that they have been able to find by trial a reasonable Bohr model of the Cl ion which, when Jauncey's formula for modified scattering is employed, gives F values at all angles in good agreement with the experimental values. The theoretical modified F curve has a kink at the same angle at which a kink occurs in the experimental curves; this kink is connected with the fact that on Jauncey's theory the M electrons cease to act as diffracting centres at this angle. A "U" curve, showing the radial distribution, has been plotted for a grating space of $D = 3\cdot06$ Å., and is similar to Havighurst's experimental curve. It is pointed out, however, that the theoretical "U" curve carries no particular information about the model from which it is derived, since here the method of Fourier analysis is invalid. H. N. A.

2257. Immiscibility in Liquid Silicates. J. W. Greig. *Am. J. Sci.* 15. *pp.* 375–402, *May*, 1928.

Systems have been examined to find the temperature at which various liquids exist in equilibrium with cristobalite. In certain systems it was

found that over a considerable range of compositions the temperature of complete melting was constant. Such a condition is explicable only on the basis that the solid phase is in equilibrium with two liquids. The globules and streaks found in such rocks as those of agate points are the products of crystallisation and in no way the result of immiscibility.
W. A. R.

2258. Periodic Classification of the Hardness and Melting Points of the Elements. S. A. Korff. *Science*, 67. *pp.* 370–371, *April* 6, 1928.

The author arranges the elements according to their atomic numbers horizontally into a table of eighteen or fewer elements, the elements of the columns showing spectroscopic similarities. Low and high melting points are then at different ends of the table, and the melting points increase down each column. Similar relations hold for hardness, and both these properties are connected with spectroscopic type and electronic configuration. Atoms slide more easily upon atoms if their shells are complete than when incomplete, and deformation by shear and compression is similar to deformation in melting. H. B.

2259. Atomic Weights and Atomic Numbers. A. v. Fischer-Treuenfeld. *Ann. d. Physik*, 85. 8. *pp.* 1113–1116, *May* 24, 1928.

Using Rutherford's model of the atomic nuclei, and certain assumptions as to their form, the packing of their particles, and the thickness of the outer " rind " or skin, the author arrives at two formulæ showing the relation between the atomic weights and the atomic numbers of the elements. These formulæ are compared in two tables, and one of them shows very satisfactory agreement with the facts. H. N. A.

2260. Distribution of Electrons among Atomic Levels. E. C. Stoner. *Leeds Philosoph. and Lit. Soc., Proc.* 1. *pp.* 226–231, *April*, 1928.

In this note it is pointed out that a number of unjustifiable applications have been made of a scheme previously put forward for the distribution of electrons among atomic levels. This is due to insufficient consideration of subsequent investigations, which have cleared up obscure points, and indicated the necessity for modifications. The classification of electrons in n, k groups is discussed, and the spectroscopic significance of X-ray levels is considered. It is shown that electrons cannot be subdivided into grouplets specified by n, k, j values appropriate for X-ray levels.
AUTHOR.

2261. Statistical Method of Investigating Electrons in Atoms. E. Fermi. *Zeits. f. Phys.* 48. 1–2. *pp.* 73–79, 1928.

The electrons surrounding an atom are regarded as a gas in a state of complete degeneration, and are treated by a statistical method based upon Pauli's principle of exclusion [see Abstract 1867 (1926)]. This renders the distribution of electrons round the nucleus and also of their velocities independent of the temperature. The author calculates the number of electrons in the atom having a given azimuthal quantum number. These only appear in normal atoms at definite values of the atomic number, and these values indicate the beginning of anomalies in the periodic system. The author shows that the anomalies thus calculated are in satisfactory agreement with observation. E. E. F. d'A.

2262. Helium Nucleus as Brick of Other Atomic Nuclei. H. Pettersson. *Zeits. f. Phys.* 48. 11–12. *pp.* 799–804, 1928.

A critical review of the problem, with special reference to Aston's new determination of mass spectra [see Abstract 3103 (1927)], which, while confirming the whole number rule, does not really support the assumption that atomic nuclei are built up of helium nuclei. The helium nucleus is only an example, and not even a specially typical one, of a universal loss of the mass of hydrogen incurred in the building up of matter from hydrogen. It is not even settled that the α-rays of radioactive elements represent pre-existent helium nuclei. The energetics of the atomic destruction seem to depend on the difference between the masses of atoms rather than upon the absolute values of the packing fractions of Aston. H. B.

2263. Unpolar Combination and Atomic Refraction. Part I. R. Samuel. *Zeits. f. Phys.* 49. 1–2. *pp.* 95–137, 1928.

Modifies the theories of Lewis by assuming that each unpolar bond is brought about by one and not by two electrons, and that in unpolar molecules one of the partners is to be regarded as positive and the other as negative; the valency electrons of the positive partner move in the field of force of both nuclei and so produce the combination. Points out the analogy between polar and unpolar combinations. When an alkali metallic atom unites with a halogen atom a valency electron of the former is separated from it in a sort of ionising process; the same idea can be employed in explaining the formation of unpolar molecules, since after the meeting of the two atoms the binding electron moves in a different orbit than the original one, and a kind of excitation of the positive atom takes place. If the electron affinity of the negative atom is large, the binding electron is separated from the positive atom, and a polar molecule is produced; if the electron affinity is small, the molecule is unpolar. Various steps are found to exist between the two limits, but the theory is capable of accounting for all known cases. A large part of the paper is devoted to the study of atomic refraction in unpolar inorganic compounds, and many interesting and consistent results are obtained, with different values of the atomic refraction for atoms in polar and in unpolar combinations. H. N. A.

2264. Absorption in Excited Hydrogen. N. Robinson. *Zeits. f. Phys.* 49. 1–2. *pp.* 137–145, 1928.

Uses a modification of the method employed by Meissner to obtain the duration of the life of the metastable terms of the inactive gases. The life of the states concerned in the absorption of the Balmer lines of hydrogen is much shorter, and the author, at the suggestion of von Traubenberg, has employed an ingenious combination of oscillatory condenser discharges with Holtz valve tubes as rectifiers to obtain frequencies of $5 \cdot 10^5$ per sec. in an attempt to measure it. This frequency, however, was not high enough to make a measurement of the duration of life possible, but it is smaller than 10^{-6} sec. H. N. A.

2265. Limits of Accuracy in Physical Measurements. A. E. Ruark. *Nat. Acad. Sci., Proc.* 14. *pp.* 322–328, *April*, 1928.

Section 1 deals with Heisenberg's uncertainty principle and the motion of free particles, and describes a device which may determine a dynamical quantity by the use of a trigger, or shutter, without spoiling the system for the observation of the conjugate magnitude. Section 2 then discusses the limits of accuracy in physical measurements taking the case of a single dynamical quantity, *viz.*, the measurement of the position of an electron initially at rest by allowing it to scatter a light quantum of given wave-length. A definite limitation is indicated which affects any attempt to study the structure of an individual electron by the use of light quanta, and this also applies to the delicacy of length measurements when the exploring instrument is a swiftly moving particle. Similar restrictions affect measurements of time and also of momentum variables. H. H. Ho.

2266. Critical Experiment on the Statistical Interpretation of Quantum Mechanics. A. E. Ruark. *Nat. Acad. Sci., Proc.* 14. *pp.* 328–330, *April*, 1928.

Born's view that probability functions refer to the average behaviour of a great number of similar systems, and Darwin's attitude based on Heisenberg's uncertainty relation that each electron in a group has the whole velocity distribution and should not be considered as possessing a definite velocity, are held to be capable of decision by the following type of experiment: A radioactive nucleus having several high-lying energy levels may emit two or more γ-ray quanta if it possesses two or more stationary modes of vibration simultaneously, and these may be capable of being recorded. Experimental data already to hand indicate that double emissions occur but seldom, if at all. H. H. Ho.

2267. Statistical Methods and Undulatory Mechanics. A. Carrelli. *N. Cimento*, 5. *pp.* 73–76, *March*, 1928.

The natural statistics of Boltzmann and the two modern statistics of Bose and of Fermi calculate the number of complexes on two different principles. The author shows how it is possible by means of undulatory mechanics to bring all three to a common base by finding the number of distinct solutions of Schrödinger's equation. A. D.

2268. Collision of Two Point Charges according to Wave Mechanics. W. Gordon. *Zeits. f. Phys.* 48. 3–4. *pp.* 180–191, 1928.

The Rutherford scattering experiment is considered, using wave mechanics, on the lines of Born's work [see Abstracts 2532 (1926) and 43 (1927)]. The Rutherford formula for the distribution of scattered α-particles is shown to hold good for arbitrary velocities. W. S. S.

2269. Quantum Mechanics of a System of Particles. E. H. Kennard. *Phys. Rev.* 31. *pp.* 876–890, *May*, 1928.

The " mechanics of a system of particles is developed on the basis of Schrödinger's wave-equation," without any use of matrices; it is shown that simple cases can be handled as easily by this method as by the matrix method. The passage to classical theory as an approximation stands out very clearly. The measurement of velocity, momentum, energy and angular momentum as secondary physical qualities is discussed, the usual probability amplitudes being obtained. The conservation of momentum and of energy is treated in terms of the new theory. AUTHOR.

2270. Physical Pendulum in Quantum Mechanics. E. U. Condon. *Phys. Rev.* 31. *pp.* 891–894, *May*, 1928.

It is pointed out that the Mathieu functions of even order are the characteristic functions of the physical pendulum in the sense of Schrödinger's wave mechanics. The relation of various properties of the functions, as known from purely analytical investigations of them, to the pendulum problem is discussed. AUTHOR.

2271. Dirac's Theory of the Spinning Electron. A. Landé. *Zeits. f. Phys.* 48. 9–10. *pp.* 601–606, 1928.

The Dirac theory [see Abstract 1168 (1928)] is slightly generalised and shown to lead to a "hydrodynamics" corresponding to that introduced by Gordon and Klein for the ψ-function of the relativistic point electron. The classical mechanical analogue of the wave mechanical spinning electron is also examined. W. S. S.

2272. Theory of Hartree's Atomic Fields. J. A. Gaunt. *Cambridge Phil. Soc., Proc.* 24. *pp.* 328–342, *April*, 1928.

A number of points are discussed dealing with the theoretical soundness of Hartree's assumptions in employing the method of self-consistent fields [see Abstract 1170 (1928)] to arrive at the energy levels for complex atoms. The general conclusion is that Hartree's method is the best available for approximating to the wave-function and energy of a complicated atom by solving equations for the individual orbits. Certain of Hartree's numerical results are, however, criticised. W. S. S.

2273. The Ether. G. Giorgi. *R.G.E.* 23. *pp.* 643–653, *April* 14, 1928.

A summary of the development of the theories of the ether. The ideas of the periods of Newton, Stokes, Maxwell and Lorentz are described and the development of the theories of Einstein and Ritz and la Rosa. Finally, a summary of the results of de Broglie's conception is given. A. Wh.

2274. Drag on the Ether. H. Mineur. *Bull. Astronomique*, 5. 5. *pp.* 379–394, 1928.

To explain Michelson's result, three methods have been adopted: the Fitzgerald contraction, restricted relativity and Stokes's hypothesis. In the last the ether follows the movements of the heavenly bodies, but is at rest at a distance from them. The author follows up Stokes's hypothesis admitting the observed law of aberration; he finds the kinematical conditions which must be satisfied by the drag; it is necessary and sufficient that it be irrotational; and if the ether were compressible, which it is shown it cannot be, its variations of density ought not to influence the velocity of light. It follows from purely kinematic considerations that the ether near the earth is at least eight times as dense as it is where at rest. There is an infinite number of laws of drag which meet these conditions, but the conditions themselves render Stokes's hypothesis very improbable. A. D.

2275. Determination of the Geoid by the Deviations from the Vertical. C. Mineo. *Accad. Lincei, Atti*, 6. *pp.* 498–502, *Dec.* 4, 1927.

Poincaré, Callandreau and Viterbi have considered the problem of the determination of the geoid from the deviations from the vertical. In this paper the problem is worked out for a body which does not deviate greatly from a sphere. A. Wh.

2276. Velocity of Propagation of Gravitation. E. Kogbetliantz. *Comptes Rendus*, 186. *pp.* 944–946, *April* 2, 1928.

It is pointed out that if a large mass be rotated below and near to a torsion balance of the Eötvös type there will be a couple exerted if the velocity of propagation is not infinite. It is shown that with a torsion fibre 4 metres long, double reflection and an optical path of 4 metres, a mass of 184 metric tons rotating at 3000 revolutions per minute, a measurable effect should be obtained for values of $\alpha < 48$ where the velocity of gravitation $= \alpha \times$ velocity of light. A. Wh.

2277. Gravity and Geodesic Measurements. C. Somigliana. *Accad. Lincei, Atti*, 7. *pp.* 184–189, *Feb.* 5, 1928.

A discussion of the gravitational field due to the ellipsoid of reference and its relation to the field as expressed by a formula of the type of that due to Helmert. A. Wh.

2278. Energy and Entropy of Einstein's Closed Universe. R. C. Tolman. *Nat. Acad. Sci., Proc.* 14. *pp.* 348–353, *April*, 1928.

The two principles enunciated in a previous paper [see Abstract 1515 (1928)] to serve as analogues in general relativity for the first and second laws of thermodynamics are used to investigate the equilibrium between radiation and matter in Einstein's closed universe. J. S. G. T.

2279. Equilibrium between Radiation and Matter in Einstein's Closed Universe. R. C. Tolman. *Nat. Acad. Sci., Proc.* 14. *pp.* 353–356, *April*, 1928.

The equilibrium concentration, N, of a perfect gas in Einstein's closed universe is deduced, applying the results contained in previous papers [see Abstract 1083 (1927) and preceding Abstract] in the form

$$N = bT^{3/2}e^{-(\alpha mc^2/kT)-(5\alpha/2)+3/2},$$

where α has the value $(4aT^3 + 3Nk/2)/(16aT^3/3 + 5Nk/2)$, and where k is Boltzmann's constant, b is a constant which assures the same starting point for the entropy of gas and radiation, T is the absolute temperature, a is Stefan's constant, m is the mass of a molecule, and c the velocity of light. The original results obtained by Stern [see Abstract 1940 (1926)] and the author [see Abstract 1083 (1927)] for flat space-time are not greatly altered by the gravitational field, but Lenz's result for the equilibrium between radiation and matter in Einstein's closed universe [see Abstract 311 (1927)] is not obtained. J. S. G. T.

METEOROLOGY AND GEOPHYSICS.

2280. Deformation of Floating Granular Mass. T. Terada and N. Miyabe. *Tokyo Univ. Earthquake Research Inst., Bull.* 4. *pp.* 21–32, *March*, 1928. *In English.*

Experiments with different types of granular materials stressed by floating on media of different viscosity are described. Such a floating layer is liable to be torn off into a number of strips parallel to its margin, with a definite statistical distribution in size. These strips drift off from the main mass. There is a striking resemblance between the various forms of the model and the actual configuration of land and water.

W. A. R.

2281. Step-Faults. T. Terada and N. Miyabe. *Tokyo Univ. Earthquake Research Inst., Bull.* 4. *pp.* 33–56, *March*, 1928. *In English.*

Experiments with sand layers in boxes with movable sides are described. These illustrate the condition of step-faulting associated with land slides. The step-faulting of sand is determined by the range of variation in the coefficients of friction of the granular mass. The distance between consecutive fault lines is given by this range and the height of the layer. There is a close formal analogy between the phenomena of step-faulting and the formation of slip-bands in overstrained metal.

W. A. R.

2282. Application of the Theory of Fluctuation to Problems in Statistical Seismology. F. Kishinouye and H. Kawasumi. *Tokyo Univ. Earthquake Research Inst., Bull.* 4. *pp.* 75–83, *March*, 1928.

The object of this investigation is to apply the theory of fluctuation to some problems of statistical seismology. The fluctuation of a number of earthquakes, instrumentally registered, taking the statistical after-effect into consideration, is examined, and the theory utilised is that given by R. Fürth: *Schwankungserscheinungen in der Physik*, 1920. AUTHORS.

2283. Correlation of the Activity of Seismic Zones in Japan. T. Takayama. *Tokyo Univ. Earthquake Research Inst., Bull.* 4. *pp.* 1–7, *March*, 1928.

The sudden change of the sense of correlation is frequently noticed in meteorological and seismological phenomena in Japan. There are cases in which the parallel change of some two elements for some five or six years is followed by the succession of the inverse change for another few years, then again the parallel change. Such a phenomenon was hitherto considered generally to be meaningless, because on calculating the correlation coefficient a very low value of the correlation is obtained. From the calculation of probability in the present paper, however, it is inferred that, though the correlation coefficient is small in the above case, there must exist some physical relation between these two elements if the phenomenon occurs repeatedly in time or in space. The seismic activities in some seismic zones in Japan were formerly found to have correlation between each other by many investigators, as the late F. Omori, T. Hirano, K. Suda, K. Shiratori and K. Wadati. In the present paper the seismic activities of all seismic regions in Japan for the last ten years are examined, and the correlation or non-correlation between them is determined not in the old but in the new sense. AUTHOR.

2284. Land Profiles on the Southern Coast of Tosa, Sikoku. H. Kishinouye and T. Kodaira. *Tokyo Univ. Earthquake Research Inst., Bull.* 4. *pp.* 57–65, *March*, 1928.

An investigation to construct the profile curves of the vertical sections perpendicular to the coast-line at different parts of the southern coast of Tosa, and thence to infer some clue for determining the amount of the past vertical displacement of this region. The results suggest that in an unknown past an upheaval occurred of 20 to 30 metres of the eastern relative to the western coast. AUTHORS.

2285. Relief of the Earth Crust on the Southern Coast of the Province of Tosa, Sikoku. T. Terada. *Tokyo Univ. Earthquake Research Inst., Bull.* 4. *pp.* 67–73, *March*, 1928.

A discussion in connection with the paper by Kishinouye and Kodaira [see preceding Abstract] of the topographical and bathymetrical features of the region in the central part of the southern coast of Tosa, especially the part near the town of Kôti. AUTHOR.

2286. Optical Analysis of Volcanic Rocks as a Means of Studying their Genetical Relationships. S. Tsuboi. *Tokyo Univ. Earthquake Research Inst., Bull.* 4. *pp.* 131–138, *March,* 1928. *In English.*

The processes occurring when crystallisation takes place from a solid magma and the successive changes occurring in the composition of the liquid are outlined. A curve is constructed called the paragenic relation of the minerals in the rocks, but as a preliminary it is necessary to find the composition of plagioclase and mafic material associated as phenocrysts in each of the rocks. An optical dispersion method is the most suitable. Actual examples of the results obtained by optical analysis are given. The advantage of this optical method of analysis is that petrographically similar rocks can be differentiated into genetically distinct groups. R. S. R.

2287. Periodicity of Approximately 21 Minutes in the Recurrence of Earthquakes. H. H. Turner. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 2. 1. *pp.* 58–71, 1928.

Eleven separate series of repetitions from different epicentres all show periods near 21 min., but the actual value of the period seems to vary as a function of the latitude. A curve is reproduced showing the variation of period with latitude, with a maximum near latitude 45° N. Only one case is found of a south latitude which fits approximately to the northern curve. In the case of the great Japanese earthquake (September 1, 1923) there is a set of consecutive shocks from near the minimum of the 21 min. period, and there is some evidence that this is liable to occur in other instances also. L. L. B.

2288. Geological Structure of the Tango Earthquake Region. H. Tsuya. *Tokyo Univ. Earthquake Research Inst., Bull.* 4. *pp.* 139–158, *March,* 1928.

2289. Oku-Tango Earthquake, 1927. N. Yamasaki and F. Tada. *Tokyo Univ. Earthquake Research Inst., Bull.* 4. *pp.* 159–177, *March,* 1928. *In English.*

The destructive earthquake of Oku-Tango, March 7, 1927, is the effect of the blocking movement, repeated in the old faulter block of the Oku-Tango Peninsula, on the west coast of the Bay of Wakasa. Two remarkable faults were formed in accordance with old dislocation lines—the Gômura fault, about 18 km. long concentric, and the Yamado fault, 7·5 km. long, directed radially with reference to the bay. The peninsula did not move as a single block. The dislocated blocks did not become quite settled after the main shock, which was followed by slight movements until they reached a stable state. W. A. R.

2290. Oku-Tango Earthquake, 1927. A. Imamura. *Tokyo Univ. Earthquake Research Inst., Bull.* 4. *pp.* 179–202, *March,* 1928. *In English.*

An account of the movements due to the earthquake is given, and a table showing the range of destruction is added. There is reason to believe that topographical change may precede earthquakes, and a network of stations to study earthquake prediction from this point of view is being established. W. A. R.

2291. Surface Inclination after the Oku-Tango Earthquake, 1927. M. Ishimoto. *Tokyo Univ. Earthquake Research Inst., Bull.* 4. *pp.* 203–222, *March*, 1928. *In French.*

Some change in inclination of the surface precedes each shock. There may be a single slope or several. In the latter case the surface displacement does not follow the fundamental movement. There are two groups of vectors, one orientated northwards and the other eastwards. Epicentre positions also correspond to the two groups. The double grouping has a fundamental relation to the two faults of Lamada and Gômura. A relation between surface inclination and barometric pressure is also indicated. W. A. R.

2292. Narrow Lake Seiches. H. Jeffreys. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 1. 10. *pp.* 495–500, 1928.

Equations of wave motion are obtained for a narrow lake with varying length and breadth in the case of waves so short that the breadth and depth do not vary by considerable fractions themselves within a wavelength. The quicker periods are found to depend only on the depth and length, and not on the breadth except at the ends. If the lake becomes shallow towards the ends, the effect on the periods is similar to that of its becoming narrower. The greatest vertical displacements, as in other cases, occur where the breadth and depth are smallest, the breadth being the most important. This result does not hold in the immediate neighbourhood of the ends. W. A. R.

2293. Focal Depths of Large Earthquakes. H. Jeffreys. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 1. 10. *pp.* 500–521, 1928.

Results of observations of near earthquakes in Europe are compared with those for two large earthquakes in America, and satisfactory agreement is obtained. The results indicate that most earthquakes have focal depths not exceeding 35 km. The variability in the times of arrival of the compressional waves at the anti-centre is discussed. W. A. R.

2294. Love Waves in a Double Superficial Layer. R. Stoneley and E. Tillotson. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 1. 10. *pp.* 521–527, 1928.

Love waves have been previously treated on the assumption that in the earth there is an outer granitic shell in immediate contact with a dense ultrabasic lower layer. This paper allows for the presence of an intermediate shell of basaltic composition. It is shown that waves may exist in which the amplitude of the disturbance in the uppermost layer is a periodic function of the depth, whilst the disturbance in the lowest medium diminishes exponentially with the depth. Waves without nodal planes are assumed. W. A. R.

2295. Wave Dispersion in a Double Superficial Layer. R. Stoneley. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 1. 10. *pp.* 527–532, 1928.

A further examination of the propagation of Love waves for a layer of granite underlain by twice its thickness of basic rock, the whole resting on ultrabasic rock, gives about 13 km. and 26 km. as the thickness of the upper and intermediate layers respectively. Accurate values of the velocities of Love waves of different periods are urgently needed to obtain more definite results. W. A. R.

2296. Integration in Tidal Dynamics. A. T. Doodson. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 1. 10. *pp.* 541–557, 1928.

The paper illustrates numerical methods of the integration of the differential equations involved in tidal dynamics, which may be used instead of the tedious summation of series hitherto employed. W. A. R.

2297. Measurement of the Second Derivatives of the Gravitational Potential over a Buried Anticline. J. H. Jones and R. Davies. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 2. 1. *pp.* 1–32, 1928.

The object of the investigation was to discover how much information could be obtained regarding a buried anticline from a knowledge of the secondary derivatives of the gravitational potential at various points on the surface. The work was carried out in South Persia on the Ahwaz fold, 4½ miles from Ahwaz. The instrument used was similar to the original Eötvös balance, but of considerably smaller dimensions. The method was to obtain three sets of readings with each balance of duplicate type with the beams in three different azimuths with respect to some fixed line, generally magnetic North and South. Observations were made hourly from sunset to sunrise, and a number for each position of azimuth. Experiments were made to test the temperature variation effects on the balance, and the results are shown graphically. The theory of the method is explained in detail, and the corrections due to terrain and topography. The results of differences of specific gravity are given and compared with test borings. It is concluded that gravity measurements with the torsion balance will give valuable information concerning the shape and dimensions of buried anticlines, and are of considerable importance to the economical testing of such structures in oil-bearing areas. R. S. R.

2298. Tides in a Flat Semicircular Sea of Uniform Depth. J. Proudman. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 2. 1. *pp.* 32–43, 1928.

The paper deals with the dynamical theory of the free and forced tides in a flat semicircular sea of uniform depth which rotates with the earth. A special case was investigated earlier [see Abstract 2554 (1926)], and the present case is on similar lines. The general problem is reduced to an infinite system of linear equations which may be solved by the method of infinite determinants. As for any flat sea of uniform depth, which is of small lateral extent and not too shallow, the first approximation to the forced tides is given by their equilibrium form. The second approximation to both the semi-diurnal and diurnal constituents is also given. These are applied to the case of a sea in latitude 45° N., approximately that of the Black Sea, and the results agree well with the observed facts. For a basin whose dimensions are about the same as those of the Black Sea the longest period of free tides is found to be about 4·4 hours. This is comparable with values of 4·98 hours found by Sterneck and 5·118 hours by Defant. R. S. R.

2299. Special Case of Tidal Motion in Elliptic Basins. S. Goldstein. *Roy. Astron. Soc., M.N. Geophys. Supp.* 2. 1. *pp.* 44–56, 1928.

The special case considered has a frequency of the harmonic motion

double the effective frequency of rotation of the sea. The expressions for free tides for a uniform depth and for forced tides are obtainable, and the tides in a basin shelving up to the coast are also considered. For the free tides an infinite sequence of critical depths is found. For that depth for which the tide considered is that of longest period, *i.e.*, for the greatest of the critical depths, the free surface is nearly plane, the corange lines nearly circular, and the cotidal lines nearly straight. The cotidal lines have a slight concavity away from the major axis; the corange lines are such that the radius vector from the centre increases slightly as we pass from the minor to the major axis. The wave moves round in the direction of rotation. The lowest critical value of β lies between 1 for a circle and 1·78 for a canal of elliptic plan. For the forced tides unless β is larger than in any practical case the free surface is again nearly plane, the corange lines nearly circular and the cotidal lines nearly straight. The tide height is greater than on the equilibrium theory, and the tide lags behind the equilibrium tide in the first and third quadrants, and is in advance of it in the second and fourth quadrants.
R. S. R.

2300. Possible Tidal Effects on Accurate Time-Keeping. H. Jeffreys. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 2. 1. *pp.* 56–58, 1928.

The effect of the tide raising potential of the sun and moon and the consequent changes in " g " and the rate of a pendulum are calculated. The amplitude of the error in time-keeping for solar semi-annual and lunar semi-diurnal tides are found. The earth's angular velocity of rotation also varies, and is comparable with the effect on a pendulum. At the equator the two effects are in the same sense, but the effect on the pendulum is reversed in high latitudes. Both the effects are very small and within the limits of error of the most accurate time measurements. R. S. R.

2301. Limits of Form and Magnitude in Desert Dunes. V. Cornish. *Nature,* 121. *pp.* 620–622, *April* 21, 1928.

Small sand ripples on the sea-shore are a few inches from crest to crest, with short, steep front and long gentle slope to windward. They are normally level-crested and long-crested. The large waves or dunes in a sea of sand subject to stormy winds are usually peaked and frequently short-crested. From observations in Egypt and elsewhere, it is inferred that if a country be silted with loose dry sand under the action of strong wind, constant in direction until the dunes attain maximum height, the skyline will be serrated by peaks which are not remnants of erosion but accumulations. G. E. A.

2302. Spiral Graph of Geological Time. D. White. *Washington Acad. Sci., J.* 18. *pp.* 201–203, *April* 19, 1928.

The author has used a partially uncoiled spiral to present in a more adequate and stimulating form a graph, and thus develop a mental picture of lapse of geological time and superposed geological history. Numbers are marked off along the spiral in hundreds of million of years for the various geological strata. This graph is equally useful to indicate the sequence and duration of time divisions, the sequence of life, the glacial epochs, the periods of volcanism or diastrophism or other features or time regulations in the earth's history. R. S. R.

ASTROPHYSICS.

2303. Origin of Spectrum of Solar Corona. M. Saha. *Nature,* 121. *pp.* 671–672, *April* 28, 1928.

The author considers Milne's work on transition probabilities of Ca$^+$-atoms, and suggests that other light atoms (Li$^+$, Be$^+$, B$^+$, C, N, O . . . Si, P, S, P$^+$, S$^+$) have been thrown out by radiation pressure or other agencies from the sun's general atmosphere. Radiation would more than balance gravity for Li, so it can only be retained in its ionised form, and since its fundamental lines are in the Schumann region may not be detected as the excitation may be too great for bringing out the next important lines. Majumdar and Kichlu have experimented in the laboratory with thallium, and find that $\lambda 5350\cdot 46$ is at least ten times more intense than $\lambda 3775\cdot 72$, giving as explanation that most of the atoms in the $3s$-state return first to the $2p_2$-state, and then by the prohibited transition to the $2p_1$-state, thus maintaining the equilibrium by the prohibited transition which marks the emission of the line $\nu = 2p_1 - 2p_2$. He applies similar arguments to silicon and to carbon, and concludes that silicon would be thrown out into the corona in the metastable state $^1S_0$, and hence that the coronal spectrum would show the prohibited transition. If so, the Fraunhofer and the coronal spectrum should show the line corresponding to $^3P_1 - {}^1S_0$, $\lambda = 6527\cdot 05$ (Rowland scale), and the silicon lines $\lambda 4103$ and $\lambda 3905\cdot 67$ should be high chromospheric lines. Similarly prohibited transitions between the fundamental levels of N and O, P and S, P$^+$ and S$^+$ may account for some of the coronal lines. A. S. D. M.

2304. Evidence for Gravitational Displacement of Lines in Solar Spectrum Predicting Einstein's Theory. C. E. St. John. *Mt. Wilson Observat. Contrib. No.* 348. *Astrophys. J.* 67. *pp.* 195–239, *April,* 1928.

The author describes briefly the solar phenomenon concerned in the problem of relativity. The gravitational displacement = M/R varies as the wave-length and for solar spectral lines = Fizeau Doppler effect of 0·635 km./sec. away from observer; the precision of measurement far exceeds the displacement; the pressure in the solar atmosphere is negligible; the Fraunhofer lines in sun or stars refer to definite levels as is seen from the solar rotation, the flow near spots, flash spectrum, spectral differences between centre and limb, progression in excitation potentials, and decrease of magnetic field strength with height above photosphere. He concludes that level of origin, not intensity of line, controls and determines the differences in displacements, and gives a table of comparative radial velocities for high and low levels for sun and stars. The progressive decrease of red shift at low levels is due to convection currents; for the displacement of high-level lines to the red as compared with medium, he adopts Milne's theory [see Abstract 2790 (1926)]; but all these line displacements at different levels are independent of relativity. He investigates 497 iron lines for sun *minus* vacuum, both for the sun's centre and limb. For the centre the region $\lambda 3917$ (level 520 km. above photosphere), the average displacement is that of relativity; at the limb for low-level lines originating at 350 (here radial currents have no effect, and there is no other agency than relativity to account for the shift to the red). He gives supplementary evidence from silicon, titanium, manganese and cyanogen [see also Abstract 791 (1924)]. A. S. D. M.

2305. Spectrophotometry of Chromosphere. C. R. Davidson, M. Minnaert, L. S. Ornstein and F. J. M. Stratton. *Roy. Astron. Soc., M.N.* 88. *pp.* 536–547, *May*, 1928. *Observatory*, 51. *pp.* 177–180, *June*, 1928.

A summary of the spectrophotometric work done by the Sumatra eclipse expedition. Some lines agree more closely with the multiplet rules than do the laboratory spectra. A table of multiplet intensities, with notes, is given. Deviations from Schrödinger and Pauli's formula—small but real—occur for lines nearer to the head of the Balmer series and for lower levels in the sun; these are not due to effects of temperature, pressure, or radiation; a table of relative intensities of Balmer lines is given, and it suggests that depth in the solar atmosphere is the chief factor in causing divergence from the formula. The 1926 lowest level coronal (more probably from a high prominence) spectrum gives the low temperature of about 2000° K. and the source of this is unknown; but the higher temperature for higher levels possibly is due to a higher proportion of reflected sunlight. Kramer's theory applied to the ultra-violet continuous hydrogen spectrum gives $T = 4000°$ for the flash and $T = 3200°$ for a high prominence. Estimate of the total radiation from the [K] line in high prominences are probably of the right order. A. S. D. M.

2306. Large Magnetic Storms and Large Sunspots. W. M. H. Greaves and H. W. Newton. *Roy. Astron. Soc., M.N.* 88. *pp.* 556–567, *May*, 1928.

A comparison between the large magnetic storms and large sunspots during the period 1874 to 1927 shows that individual storms and individual spots are associated with each other more often than can be ascribed to mere chance. The tendency to association appears to be greater for the very largest storms of all. It would seem that whatever solar activity is responsible for a magnetic storm, if it is sufficient to produce an unusually large storm, it will probably manifest itself as a large sunspot. But attention has been called to a case of a very large storm taking place at a time when only very moderate spots were visible. No very definite evidence has been found of a tendency for these large storms to be followed by another magnetic disturbance after an interval of one solar rotation. The evidence available suggests that there may be a slight tendency for recurrence, but it is not very conclusive. AUTHORS.

2307. Inexpensive Solar Telescope and Spectrohelioscope. G. E. Hale. *Nature*, 121. *pp.* 676–680, *April* 28, 1928.

The spectrohelioscope consists of two slits carried on opposite ends of a very light metallic bar (oscillated rapidly by a small electric motor) mounted on a bearing half-way between them, the first slit being in the focal plane of the spectrum and permitting only the light of the line in use to reach the observer's eye. The observer sees by persistence of vision through the oscillating second slit (on the H_α line) a hydrogen image of a portion of the sun; if at the sun's limb a prominence may appear light against the sky and on the disc as a flocculus. If the H_α line is distorted by large radial velocity so as to be completely outside its normal position, a simple "line-shifter" is employed. The chief difference between this instrument and a spectroheliograph is that the latter builds up its image gradually, slit-width by slit-width, but that the spectrohelioscope shows a considerable area at once, involving rapid motion of the slits or of the solar image. The author describes three successful systems of moving slits, and three means of producing rapid motion of the solar image with respect to fixed slits. He gives illustrations of the small solar telescope and of the spectrohelioscope constructed in August 1927. For this a 4-in. grating is essential, but as satisfactory replicas of this size are not yet obtained, he has, for the present, used a pair of 60° prisms [see also Abstract 323 (1927)]. A. S. D. M.

2308. Motor Micrometer of Glasgow Transit-Circle. L. Becker. *Roy. Astron. Soc., M.N.* 88. *pp.* 604–606, *May*, 1928.

Since the ordinary impersonal micrometer requires the use of both hands, the author has designed an electrically driven micrometer, running 280 revolutions per sec. without appreciable variation, and whose gear-box permits an alteration of the period of the micrometer screw rotation according to declination. Photographs are given of the apparatus, which is described with the procedure of registering a transit. When the telescope is directed to its collimator the running of the motor produces no effect on the field of view. On the first night of trial he obtained a greater accuracy than that obtained by another mode of observation. A. S. D. M.

2309. Variability of Earth's Rotation. J. A. Pearce. *Roy. Astron. Soc. Canada, J.* 22. *pp.* 145–147, *April*, 1928.

A very brief summary of the investigations by means of the motions of the moon, sun, Venus and Mars, the eclipses of Jupiter's satellites, and the transits of Mercury, of the variability of the earth's rotation, by Newcomb, Cowell, Brown, Glauert, Ross, Innes and Jones. A. S. D. M.

2310. Moon's Diameter Determined from Total Solar Eclipse Photographs. J. A. Miller and R. W. Marriott. *Astron. J.* 38. *No.* 898. *pp.* 101–105, *April* 10, 1928.

A test of the Einstein effect whether the bending of light rays is due to our own atmosphere, by measuring short exposure images of the moon taken during the Sumatra eclipse of January 14, 1926, and comparing them with the computed theoretical diameter. The instrument, plates, methods of photography and measurement are described, and the authors conclude (1) that it is possible to obtain a reasonably accurate diameter from the measures of short exposure photographs of the moon made during eclipse, and (2) that no measurable effect has been found that could be interpreted as accounting even in part for the deflection of light from stars apparently near the sun's limb observed at the time of total solar eclipse. A. S. D. M.

2311. Wireless Time Signals and their Application. J. P. Henderson. *Roy. Astron. Soc. Canada, J.* 22. *pp.* 77–93, *March*, 1928.

The author refers first to the form of the signal sent out by different stations and the advantages possessed by the vernier signal in comparison with the direct signal. In the comparisons of time he deals with the coincidence method and also with syphon recorders working on either a tape or a drum along with the clock to be compared. A number of practical details are discussed regarding different types of receiving sets and minor alterations to the sets which were found to be advantageous. He refers finally to the use made of these time signals by magnetic and

gravity survey staffs in Canada, in the marking of seismograph records, and thus assisting in the location of earthquakes and of faults in the earth's crust, for longitude comparisons, and in the timing of eclipses.
R. S. R.

2312. Seasonal Changes in Day Lengths. H. C. Plummer. *Roy. Astron. Soc., M.N.* 88. *pp.* 618–622, *May*, 1928.

The author examines the rate of change in the length of the day by means of the equations $\sin D = \sin \omega \sin L$; $\cos T = -\tan \phi \tan D$, finding that two cases must be distinguished. In the sub-Arctic zones with the present value of the obliquity of the ecliptic between latitudes 61°·1 and 66°·5, the rate of change in the length of the day becomes greatest at an intermediate date in each quarter, and is less at each equinox than before or after (in latitude 61°·1 the two maxima coalesce with the minimum at the equinox, leaving a trace in the flattening of the equinoctial maximum); in lower latitudes the greatest rate occurs at the equinox. In higher latitudes where the sun becomes circumpolar, the rate of change only becomes stationary at the equinox, and in both directions away from this the rate of change in the length of the day increases. The author notes that in the meteorologically important sub-Arctic zone where the changes are most marked, the geometrical condition tends to produce meteorological regularity.
A. S. D. M.

2313. Effect of Collisions on Monochromatic Radiative Equilibrium. E. A. Milne. *Roy. Astron. Soc., M.N.* 88. *pp.* 493–502, *April*, 1928.

The author defines *local thermodynamic equilibrium* (*l.t.e*) obtaining for the equation of transfer, Schuster's $dI_\nu/\rho ds = -k_\nu I_\nu + k_\nu B_\nu$, and *monochromatic radiative equilibrium* (*m.r.e.*) Schwarzschild's $dI_\nu/\rho ds = -k_\nu I_\nu + k_\nu \int (I_\nu d\omega/4\pi)$. On the condition that the state at P is steady as regards the distributions of atoms at P amongst their stationary states, the equation of transfer at high densities is shown to lead to Schuster's form, at low densities to Schwarzschild's. An assembly is considered containing atoms of two stationary states only (lower energy or normal state 1, higher energy or excited state 2) mixed with other atoms, ions, and electrons, taking account of collisions in exciting (collisions of the first kind or inelastic) and de-exciting (collisions of the second kind or super-elastic) atoms in states 1 and 2 respectively. If the assembly is in *t.e.*, the super-elastic collisions exactly balance the inelastic, and hence at the (parameter) temperature T, the probability coefficients $b_{1\rightarrow 2}/a_{1\rightarrow 2} = q_2 e^{-h\nu/kT}/q$. This equation holds good in general. For the equation of transfer in the steady state, the author obtains $dI_\nu/d\tau_\nu = -I_\nu + [\int I_\nu (d\omega/4\pi) + \eta B_\nu(\tau)]/(1 + \eta)$, where $\eta = \epsilon/B_\nu(\tau) = (b_{1\rightarrow 2}/B_{1\rightarrow 2})(e^{h\nu/kT} - 1)/\sigma$, and infers that we begin at the stellar boundary with *m.r.e.*, and pass inwards continuously to *l.t.e.*; the higher the density the more the atoms emit according to Kirchhoff's law. He evaluates η approximately, and proposes a model of the stellar atmosphere of three layers, $\eta = 0$, or 1 or ∞, corresponding to increasing depths. The passage is made from *l.t.e.* to *m.r.e.* at $\eta = 1$ where $P_e = 10^{-3}$ atmos., but this is probably an over-estimate of pressure. This paper deals only with the atoms producing the core of the absorption line. He points out that η is a variable; that the collision radius of an atom varies with excitation and de-excitation; and that some measure of *m.r.e.* holds for all lines, for else the line should merge into the continuous background at the boundary, which it does not. A. S. D. M.

2314. Comment on Certain Equations in the Theory of Radiative Equilibrium. K. P. Williams. *Astrophys. J.* 67. *pp.* 296–304, May, 1928.

An examination is made by means of the theorem of mean values of a series of equations that occur in Eddington's theory of radiative equilibrium. The result disagrees with Eddington's conclusion. A form for the variation of temperature and density within a star is assumed, which allows the equations to be integrated, and results that confirm the general discussion are obtained. AUTHOR.

2315. Ballistic Theory of Variable Stars. C. Cannata. *Accad. Lincei, Atti,* 6. *pp.* 296–300, *Nov.* 6, 1927.

The type of variation to be expected according to the ballistic theory of radiation in the case of double stars is examined. It is considered that the expected phenomena will generally resemble the behaviour of Cepheid variables, and in a later paper it is proposed to apply the theory to a particular case. A. Wh.

2316. Measures of Sixty-Seven Double Stars. R. W. Marriott and J. H. Pitman. *Astron. J.* 38. *No.* 896. *pp.* 81–87, *March* 28, 1928.

2317. Origin of Nebular Lines and Structure of Planetary Nebulæ. I. S. Bowen. *Astrophys. J.* 67. *pp.* 1–15, *Jan.*, 1928.

Eight of the strongest nebular lines are classified as due to electron jumps from metastable states in N_{II}, O_{II} and O_{III}. Several of the weaker lines are identified with recently discovered lines in the spectrum of highly ionised oxygen and nitrogen. The lines thus identified are shown to behave in various nebulæ in a way consistent with the foregoing classifications. A similar study of the few lines yet unknown makes it possible to estimate the stage of ionisation from which they arise. On the basis of the foregoing identifications, the relative sizes and intensities of the monochromatic images of the planetary nebulæ are explained by an extension and modification of the ideas developed by Zanstra for hydrogen in the diffuse nebulæ. AUTHOR.

2318. Temperatures of Stars in Planetary Nebulæ. H. Zanstra. *Nature,* 121. *pp.* 790–791, *May* 19, 1928.

Slitless spectrograms of a nebula and its central star are compared with sensitometer comparison spectra (with daylight as source) of varying intensities and of the same exposure times as the nebula. Independent determinations of the temperature of the central star (assumed a black body) were found: (1) from the intensity data of the spectrum assumed to be produced from recombination after complete absorption of the ultra-violet light beyond the head of the series, causing ionisation of the atoms or ions in the nebula; (2) that a photoelectron freed from any atom or ion is only recaptured after its energy as a free electron has been completely exhausted in producing the nebulium lines, it being assumed in the present case that the hydrogen absorbs all the ultra-violet energy of the star beyond the head of the Lyman series, and that the electrons thus freed lose their energy completely in exciting the nebulium lines, since the images of the hydrogen and of the green nebulium lines are nearly coincident. For three nebulæ (N.G.C. 6540, 6572 and 7009) he obtains provisional results and deduces that it is fair to assume that the star is a black body, and that the luminosity is caused by known physical mechanisms. He tabulates the difference (*d*) of intensity of wave-length 4250 Å. (which varies with the photographic brightness of the central star) from the visual brightness of the nebula (mainly due to the green nebulium lines) expressed in magnitude, with the temperature (T) expressed in thousands of degrees, and so obtains a scale from which he deduces the temperatures of eighteen nebulæ. A. S. D. M.

2319. Nebulosities in Monoceros, Taurus and Perseus. F. E. Ross. *Astrophys. J.* 67. *pp.* 281–295, *May*, 1928.

Two 3-in. doublets of 21 in. focus, correlated for photographic and photovisual rays, are mounted with the Bruce 10-in. Petzval and the 6-in. Voigtländer lenses, and all exposed for the same time. The maximum difference (2·6 magnitudes) in light grasp is obtained by a very short exposure, after which the smaller lens gains in efficiency so that with two hours' exposure the difference is 1 mag. and longer exposures gain no fainter stars. The author suggests that the specific intensity of the light in the tremor disc must be at least equal to the specific intensity of the fogging light for the image to become visible, and this for a given telescope corresponds to a certain *stellar* magnitude, m_0, which is the limit for that telescope; beyond there is increase in density, only without increase in contrast. He applies this to various cases, and shows that the size of the tremor disc should be reduced to the lowest possible. But the limiting *stellar* magnitude does not apply to *nebulosity*, and he shows that, with extended exposure, the refractor gains in efficiency over the reflector. For very faint nebulosity the fastest photographic emulsion must be used, and he discusses the calibration curve of the Eastman speedway plate developed with the Eastman formula, D 11, for ten minutes at temperature 70°; the effects of pre-exposure on this plate; the effect of backing; and the photographic action of general sky illumination, especially of *starlight* action as compared with *auroral*. In methods of reproduction, he shows that, whereas in the past astronomers could see more in their negatives than they could reproduce on their prints, this is now reversed, and he describes his processes, which depend partly on the degree or fullness of development of the original negative. He finds it necessary to go to a third negative in all of his four transfer processes, which are in all cases by contact and in duplicate. He gives three plates in illustration. A. S. D. M.

2320. Absorption by Nebulosity and Temperature and Luminosity Sequences of Novæ. M. C. Johnson. *Roy. Astron. Soc., M.N.* 88. *pp.* 380–393, *March*, 1928.

The author assumes that two criticisms must be satisfied: (*a*) adequacy of the supposed cause; and (*b*) its sufficient frequency to account for frequent novæ. He therefore rules out as cause any sudden increase of a star's internal energy or a collision between star and either a star or meteor stream. He accepts as possible the entrance of a faint star in or into one of Eddington's sub-condensations (density 10^{-17} gm.), but the faint star must be a low-temperature dwarf (say 3000° effective temperature). The outbreak would be due, as a secondary result of accretion of matter, to the medium repressing the star's energy; the postponed liberation, after a long period of imprisonment, might take place so violently as to give nova-like effects. There should be a long and gradual dimming of the star (say 200 years) while it proceeds through the sub-condensation, but this might escape notice in a star intrinsically faint. A. S. D. M.

2321. System of Procyon. H. S. Jones. *Roy. Astron. Soc., M.N.* 88. *pp.* 403–441, *March*, 1928.

The author gives the elliptic orbits by See, Auwers and Boss. For meridian observations he follows Auwers, supplementing his material, giving tables of q and r from 1755 to 1925. For radial observations, 47 plates taken at the Cape Observatory between 1909 and 1912 and 72 plates between 1922 and 1924 were measured in the Hartman spectro-comparator. These two methods give somewhat discordant results, and also with the double-star observations of Procyon. The elements finally adopted are $\tau = 1886{\cdot}50$, $P = 40{\cdot}23$ yrs., $n = 8^\circ{\cdot}9485$, $i = +30^\circ{\cdot}6$, $\omega = 307^\circ{\cdot}8$, $e = 0{\cdot}310$, $a = 1''{\cdot}020$, and $V = -3{\cdot}59 + 1{\cdot}320 \cos (v + 65{\cdot}7)$. The double-star observations (from 1896·93 – 1924·19) indicate the masses of the bright and faint stars as 1·24 and 0·39, but the increase of these over Boss's values (1·18 and 0·37) is not sufficient to bring Procyon into agreement with the mass-luminosity relationship as given by Eddington, and it does not seem possible to account for the discordance by possible errors of the relevant orbital elements, but a slight reduction in the adopted parallax would reduce it, and more parallax measures for Procyon are needed. A. S. D. M.

2322. Probable Error of Stellar Parallaxes. J. J. Nassau. *Roy. Astron. Soc., M.N.* 88. *pp.* 441–447, *March*, 1928.

The author notes that if a series of parallax observations is divided into groups with different average probable error, the observed distribution of each group is practically the same, indicating that the individual probable error does not measure its precision, and that the probable errors in the series are distributed according to the Gaussian law irrespective of the magnitude of the parallaxes. 700 parallaxes are used, divided into three groups, and the results are exhibited in seven diagrams. If the probable errors are grouped with reference to the number of plates used in their determination, the same symmetry of distribution is revealed.

A. S. D. M.

2323. Correction of Group of Parallax Observations and Determination of the Main Series. J. J. Nassau. *Roy. Astron. Soc., M.N.* 88. *pp.* 583–594, *May*, 1928.

The aim of this paper is to apply corrections to the 700 parallaxes of the Leander McCormick Observatory (of which one in seven is negative) so that negative parallaxes are removed; thus facilitating the determination of the main series [see preceding Abstract]. Tables and figures exhibit the observed and the true distribution, the latter being given by the formula $Y = -(2h)^{-2}y^{II} + (2!)^{-1}(2h)^{-2}y^{IV} - \ldots$, the value of h being obtained from the average probable error; 46 % of the parallaxes so corrected lie between $0''{\cdot}000$ and $0''{\cdot}020$ as compared with 20 % uncorrected. Absolute corrected magnitudes were obtained from these corrected relative parallaxes, and a table summarises the results. Distinct separation between giants and dwarfs is not achieved, but this method of correcting is bound to give better individual parallaxes, and if the number of stars in each spectral class were sufficiently great to be dealt with separately, more satisfactory results would follow. The author discusses the main series and the probable error of spread in each separate class, the case of the dwarf Ko stars being given in full in a table of three groups of 24, 14 and 21 stars respectively. Dwarf Ko stars are somewhat above the main series with great spread, and giant Ko stars much below the giant line. [See also Abstract 333 (1927).] A. S. D. M.

2324. Determination of Dynamical Parallaxes. H. N. Russell.

Astron. J. 38. *No.* 897. *pp.* 89–99, *April* 4, 1928.

The term *dynamical parallaxes* is substituted for *hypothetical parallaxes* where this is derived from an estimate of mass. For "physical pairs" statistical methods must be employed, and the author describes and criticises three formulæ: (1) Russell and Hertzsprung's, (2) Jackson's, (3) Comstock's. He gives tables of statistical distributions for (1) and (3), and distribution of statistical errors for (2), (1), and (3), which depend respectively on apparent angular velocity, linear velocity, and acceleration of the companion relative to the primary, each taking much more into account than the preceding. Comstock's formula is inferior in accuracy to the other two, which are nearly equally good, but Russell and Hertzsprung's appears to be preferable on the whole. He deals with the factor depending on the masses which can be derived from theoretical considerations by Eddington's theory of stellar luminosity. Since the latter determined his constants from a single star (Capella), the author compares these with the results from 29 well-observed binaries, finding them too great, but that agreement can be obtained by applying the correction $+ 0^{m}\cdot 50$ to Eddington's absolute magnitudes. The dynamical parallaxes derived for physical pairs with the aid of the mass-luminosity relation have probable errors ranging from 23 % for dwarfs to about 30 % for giants; they are therefore comparable in accuracy with spectroscopic parallaxes, and are better than individual trigonometrical parallaxes for stars remoter than 50 parsecs. He summarises: the dynamical parallax p of a binary star, for which an orbit is available, is given by $p = nd_1 = naP^{-\frac{2}{3}}$, where a and P are the observed mean distance and period in years; for physical pairs in which the observed arc is small, the dynamical parallax h is given by $h_1 = nh$, $h_1 = 0\cdot 418\sqrt[3]{s\omega^2}$, where s is the observed distance and ω the observed relative motion in seconds of arc per year. To find the factor n (which depends essentially on Eddington's mass-luminosity law) three tables are given. In a postscript the author criticises Redman's paper [see Abstract 871 (1928)].

A. S. D. M.

2325. Secular Parallaxes of Faint Stars. J. Schilt.

Roy. Astron. Soc., M.N. 88. *pp.* 594–596, *May*, 1928. *From Publ. of the Astron. Soc. of the Pacific.*

The author has found that the mean parallactic motion of stars does not invariably decrease with decreasing brightness. The G5 stars show a normal decrease up to a certain magnitude, beyond which giants begin to be rare, the fainter stars being in the main sequence. This phenomenon can also be detected in all spectra taken together near the galactic poles, since the A and early F stars are there usually brighter than the tenth magnitude. He examines 566 photographic proper motions between photographic magnitudes 8 and 14 in Coma, published by Ölander, and gives a table of them according to magnitude, utilising *median* magnitudes instead of arithmetical mean, together with the parallactic motions computed for the median values of $\mu_\alpha \cos \delta$ and $\mu\delta$ on the assumption of the apex at 270°R.A. and + 30° Dec. Both curves show the predicted reversal, indicating that it is not legitimate to assume that the proper motions of stars of the twelth magnitude are negligible or small as compared with those of stars of the eleventh or tenth magnitudes; and that the relative parallax of an 11·5 star should as a rule be negative if the comparison stars are one magnitude fainter. [See also Abstract 303 (1928).] A. S. D. M.

2326. Use of the Hodographic Method of Laves for Determining Elements of Spectroscopic Orbits. A. Pogo. *Astrophys. J.* 67. *pp.* 262–268, *April,* 1928.

In the recapitulation of the theory of the method of Laves, the centre of the orbit (intersection of conjugate diameters) is taken as the origin of the hodograph instead of the principal focus (intersection of the line of nodes with the line of apsides). It is shown that the length $a \sin i$ (km.) of the major semi-axis (mean distance) of the inclined orbit is given by the ratio of the numerical value (km./sec.) of the equal but opposite vectors representing the orbital velocity across the minor axis (mean orbital velocity) to the mean instantaneous motion (radians per second of time) in the orbit. The practical application of the hodographic method is simplified by placing the centre of the hodographic circle on the Schwarzschild S-axis of the velocity curve. The longitude ω of the periastron is read off directly without the use of a table of sines. The eccentricity e of the orbit is obtained as the ratio of the distance between the origin and the centre of the hodographic circle to its radius K without making use of the scale of radial velocities. The length of the major semi-axis and the value of the mass function are obtained by measurement of the horizontal half-chord through the origin of the hodograph, and by simple multiplications, without the use of a table of logarithms. The hodograph shows that the periastron point and the γ-axis must be on opposite sides of the mean S-axis, as implied by the formula $S = \gamma + Ke \cos \omega$. AUTHOR.

2327. Orbit of the Spectroscopic Binary 4 β Trianguli. O. Struve and A. Pogo. *Astrophys. J.* 67. *pp.* 336–340, *May,* 1928.

The orbital elements of this spectroscopic binary were derived from 41 spectrograms obtained with the Bruce spectrograph of the Yerkes Observatory. A least-squares solution was made using only 22 spectrograms taken in 1927–1928. $\gamma = + 10{\cdot}4$ km./sec.; P = 31°/·4009; $e = 0{\cdot}456$; K = 26·1 km./sec.; $\omega = 293^\circ{\cdot}9$; T = 1927 Nov. 6·660 U.T.; $a \sin i = 9{,}930{,}000$ km.; the mass function is 0·0397. The measurements refer to the brighter component of the system. The presence of the spectrum of the fainter component is suspected at maximum relative velocity. AUTHORS.

2328. H.D. 163181, A Spectroscopic Binary. M. L. Humason and S. B. Nicholson. *Mt. Wilson Observat. Contrib. No.* 353. *Astrophys. J.* 67. *pp.* 341–346, *May,* 1928.

Bright hydrogen lines were discovered in the spectrum of H.D. 163181 during the systematic search for Be stars carried on at Mount Wilson by means of objective-prism photographs on red-sensitive plates. Slit spectrograms indicated that it is a spectroscopic binary with a large range of velocity and that the bright lines are variable in intensity. The period is 12·0040 days and the velocity range nearly 400 km./sec. The eccentricity is small, and the mass function, $\frac{m_1^3 \sin^3 i}{(m + m_1)^2}$, equals 8·84☉. The system is therefore one of the most massive known. AUTHORS.

2329. Orbit of the Spectroscopic Binary H.R. 7200. P. M. Millman. *Roy. Astron. Soc. Canada, J.* 22. *pp.* 143–144, *April,* 1928.

2330. Radial Velocities of Stars Brighter than Visual Magnitude 5·51 as determined at Mount Hamilton and Santiago. W. W. Campbell with J. H. Moore. *Lick Observat., Publ.* 16. [399 *pp.*]. 1928.

2331. Measures of the Variable Radial Velocity of α Coronæ Borealis. J. Hartmann. *Astrophys. J.* 67. *pp.* 269–271, *April,* 1928.

Measures are given of forty-two spectrograms of this star, which was found by the author in 1903 to vary in its radial velocity. A single plate of the series shows a number of fine lines not seen on other plates. Similar conditions were found by the author for the star Algol when its spectrum was photographed at minimum phase. The peculiar plate of α Coronæ was taken at exactly the time of minimum, as deduced from later photometric measures by Stebbins. The fine lines are regarded to be due to absorption in the atmosphere of the eclipsing companion. AUTHOR.

2332. Motion of Stars. J. S. Plaskett. *Roy. Astron. Soc. Canada, J.* 22. *pp.* 111–134, *April,* 1928.

The author summarises our knowledge of the stars as regards their radial motions, positions, proper motions, space motions, the sun's motion relative to them, moving clusters, star streaming and the asymmetry in stellar motions. In this last, Stromberg has found preferential trends in the motions of certain classes: high-velocity stars, red variables, globular clusters, and non-galactic nebulæ, all being directed substantially to a point in Cepheus and along the galactic plane towards longitude 61°. This asymmetry of motion will not fit in with the explanation that star streaming is due to gravitational attraction of the local stellar system directed towards the centre. But a hopeful suggestion is that by Lindblad of a rotation of the whole galactic system. The author describes this hypothesis with some particularity and also Oort's confirmation of it, showing that three-fifths of the gravitational force arises from a mass concentrated near the galactic centre which he computes to be sixty thousand million times the sun's mass. He also searches into the effect of this galactic rotation on radial velocity, and cites the work on this done at Victoria Observatory, B.C. A. S. D. M.

2333. Comparator Suitable for Measuring Narrow Spectra in the Determination of Stellar Radial Velocities. M. Hamy. *Comptes Rendus,* 186. *pp.* 1392–1393, *May* 21, 1928.

For the degree of precision attainable with his comparator, the author substitutes for the stellar spectrum a second solar spectrum reduced to 0·1 mm., and finds that the narrowness of this does not affect the exactness of pointing [see Abstract 2245 (1927)]. A. S. D. M.

2334. Recent Light-Curves of R Scuti. P. M. Ryves. *Roy. Astron. Soc., M.N.* 88. *pp.* 483–485, *March*, 1928.

Curves are given for the years 1926, 1927 and 1908. 1926 had three double maxima of mag. 5·4 (separated by shallow minima which are all of nearly the same depth, 5·9), and two faint minima which are of equal depth, 7·2. 1927 had a faint minimum in October of mag. 8·4, after having been above 6·3 for eight months. In 1908 R Scuti never fell below 6·3.

A. S. D. M.

2335. Wave-Lengths in B Stars. S. Albrecht. *Astrophys. J.* 67. *pp.* 305–318, *May*, 1928.

The author's aim is the redemption of some early results, based on the Rowland system, now known to be vitiated by influences such as pressure shifts, etc. He gives, in a condensed form, wave-lengths of helium by Frost and Adams, of enhanced oxygen and nitrogen by Clarke and Fowler, of doubly enhanced silicon by Barrell, of the helium doublet at 4713 by Merrill, of titanium by Brown and Crew; also revised means of the radial velocities for individual stars. The results have been used in discussions of the *k*-term, of relativity displacements and of general convection currents in B-star atmospheres; they serve to emphasise the caution which is needed in choosing wave-lengths. Laboratory wave-lengths should be used rather than values derived from stellar spectra except in cases such as *c* Carinæ where lines are of unknown origin.

A. S. D. M.

2336. Distortion of Continuous Background by Wide Absorption Lines. Cecilia H. Payne. *Nat. Acad. Sci., Proc.* 14. *pp.* 296–301, *April*, 1928.

An investigation into the relative strengths of successive members of the Balmer lines for O*d* to FO stars [see Abstract 1215 (1928)]. A figure gives the percentage light loss for eight stars divided into two groups (the super-giants β Orionis and α Cygni being one group). The super-giants' lines are winged very slightly, and they therefore furnish the best available astrophysical evidence on the relative intensities of Balmer lines. This is not much altered by increase of temperature, but is altered with width and wingedness, suggesting that the true line depths are in the same ratio as for super-giants, the wings of other stellar lines cutting down the continuous background. For the form of this a comparison is made between α Cygni and Vega; the two backgrounds begin to differ about $H\zeta$. A table shows (when the curves are shifted so as to bring them best into general coincidence) that the resulting continuous background for Vega coincides sensibly with that of α Cygni in harmony with their temperatures, if it is assumed that the true relative intensities of the Vega Balmer lines are the same as for α Cygni. It is concluded that strong Balmer lines disturb the ultra-violet background, and therefore temperature measures must not be based on this region. They affect systematically colour indices, and this will show up in the narrow-lined super-giants, and also in the very luminous but apparently faint *c*-stars (with narrow lines) in clusters or the magellanic clouds, making them differ from nearby stars of the same class.

A. S. D. M.

2337. Theory of Outer Layers of Pulsating Star. J. J. M. Reesinck. *Roy. Astron. Soc., M.N.* 88. *pp.* 502–506, *April*, 1928.

In a previous paper [see Abstract 2240 (1927)] the author examined on a very much simplified model the outer layers of a pulsating star; Eddington [see Abstract **2482** (**1927**)] gave a more exact treatment and criticised this paper adversely. The author now examines the points of difference, finding his serious neglect was that k was taken as constant instead of proportional to the temperature, whilst the variability of a (neglected by Eddington) was taken into account. When his equations and conclusions are altered accordingly, the results are in agreement with Eddington's. A. S. D. M.

2338. Construction of Tables by Interpolation. L. J. Comrie. *Roy. Astron. Soc., M.N.* 88. *pp.* 506–523, *April,* 1928.

The author surveys the Lagrangian method (advocated by Pearson) and the method of breaking down one of the difference columns of the original or pivotal values to give the corresponding column of the interpolates. He submits that the Lagrangian method is too laborious, does not lend itself to ordinary machines in the case of a many-figure function, and errors are liable to pass undetected; it involves the use of large quantities and coefficients. He advises a modification of the second method which gives almost complete security against accidental error and lessens labour, especially seizing the advantage when the final stage begins with the smallest quantity involved. Its fundamental idea is that the end figure only of each interpolate should be found first, and by differencing these figures the end figures of the successive differences are found and a stage reached when it is possible to infer the whole difference when its end figure is known. He gives directions, numerical examples, and a plate of the work of the tabulating machine through which the selected cards are passed in order. A. S. D. M.

2339. Occurrence of Discordant Observations and New Method of Treating Them. K. Ogrodnikoff. *Roy. Astron. Soc., M.N.* 88. *pp.* 523–532, *April,* 1928.

The author shows that if the mean error changes during a series of observations, the resultant frequency curve of residuals must show an excess of large residuals as compared with what is predicted by the Gaussian law, and he introduces the notion of "mean weights" of observations differing by the same amount from the mean value of the unknown quantity; he gives a formula for the determination of these weights; the weights prove to be diminishing with increasing deviations. A. S. D. M.

2340. Law of Stellar Distribution derived from Proper Motions. W. M. Smart. *Roy. Astron. Soc., M.N.* 88. *pp.* 567–583, *May,* 1928.

Stellar distribution is well studied from space velocities since these show less dispersion than luminosity. The author's aim is to obtain a general theory for any region in the sky and for the distribution of proper motions in any position angle, and to compare the theoretical distributions of the proper motions with the observed in a particular region. He adopts Dyson's density function, $D(r) = Ae^{-h^2k^2r^2}/r$, and obtains $N(\mu, \theta) = N\{\phi(hV, \theta - \theta_1) - \eta^2\phi(hV, \theta' - \theta_1)\}/2\sqrt{\pi}$. [The author had already tabulated values of $\phi(hV, \theta - \theta_1) = e^{-h^2V^2}f(\tau)$, see Abstract 944 (1927).] In any region of the sky there are, in general, two drifts each with its characteristic constants, N, hV and θ, and the observed data must be compared with the combined theoretical results derived from two equations of the above type. He examines three methods of doing this, and adopts that which is concerned with the total number of stars in the region with proper motions exceeding a certain value. He obtains $R(\mu) = N\{1 - \eta^2 e^{-k^2V^2(1-\eta^2)}\}$ and computes the values of each drift for $\mu = 2'', 3'', \ldots 8''$ in succession and for different values of k. This method gives a definite result, and observation and theory are in close accord if k is about 0·3. He applies the theory to the 3029 stars in the eight groups of regions photographed at Cambridge [see Abstracts 944 and 3073 (1927)], where k is also 0·3 or 0·4, and he discusses its values in other regions of the sky. A. S. D. M.

2341. Period, Velocity Curve and Spectrum of Cepheid Variable U Vulpeculæ. R. F. Sanford. *Mt. Wilson Observat. Contrib. No.* 352. *Astrophys. J.* 67. *pp.* 326–335, *May,* 1928.

Five observers show the U-vulpeculæ light-curves as asymmetrical, four as symmetrical. In 1907 Seares found a formula in accordance with its minimum phases, but this is now too short, and the author gives new elements which also bring Seares' phases into agreement with those given by the Mt. Wilson spectrograms for 1926–27. But the Mt. Wilson spectrograms for 1918 stand out, and may indicate a slow variation in the period. The spectrum is cG4 at median magnitude with enhanced lines; maximum relative intensity coincides with light maximum, and minimum relative intensity precedes slightly minimum light, which is opposite to what occurs when a giant passes to a dwarf, but is consistent with the assumption that calcium low energy-level lines (especially of iron) are at a somewhat lower temperature in super-giants, and are therefore strengthened. A. S. D. M.

2342. Observations of Novæ, 1927–1928. W. H. Steavenson. *Roy. Astron. Soc., M.N.* 88. *pp.* 615–618, *May,* 1928.

2343. New Eclipsing Variable B.D.—20°2009, H.V. 4454. L. Campbell. *Harvard Coll. Obs., Bull.* 858. *pp.* 1–5, *May* 1, 1928.

2344. Orbit of Comet 1927 IX (Skjellerup). A. C. D. Crommelin. *Roy. Astron. Soc., M.N.* 88. *pp.* 596–600, *May,* 1928.

From the photographic positions obtained in South Africa on December 6 and 7 (1927) and February 10 to March 31 (1928), the author has derived accurate elements. There is no appreciable departure in the orbit from a parabola. An ephemeris is given for November 28 to December 26 (1927). Spectroscopic measures give the maximum (90 km. sec.) recession from the earth between December 19·5 and 20·5. The author corrects an error in M.N. 88, p. 487 in the R.A. of the radiant of possible meteors from this comet. A. S. D. M.

LIGHT.

2345. Light of the Night Sky: its Intensity Variations when Analysed by Colour Filters. Part III. (Lord) Rayleigh. *Roy. Soc., Proc.* 119. *pp.* 11–33, *May* 1, 1928.

The author discusses the results obtained from observations of the intensity of the light of the sky at night at twelve widely scattered foreign and two British stations. The same method was employed as on former occasions, but the standard light used for comparison was that from potassium uranyl sulphate. Colour filters were used to separate the green (auroral) region from the red and blue regions. The same general range of intensities was found for foreign and British stations, but much of the variation is irregular. The range of intensities is usually greatest for the auroral region and least for the blue. The five years' observations at Lerwick and Terling, Essex, indicate an annual period with a maximum in October. There is also a definite increase of sky brightness during these five years, probably associated with the change of solar activity from a minimum to a maximum. In the southern hemisphere the annual periodicity is reversed in phase, while the range decreases towards the equator. The reasons for the distinction between polar and non-polar auroræ are recapitulated, particularly the difference of intensity. For future investigations a photoelectric cell is to be used to increase the accuracy of the photometer measurements. [See also Abstract 504 (1926).] R. S. R.

2346. Four Variables Controlling Vision. P. W. Cobb and F. K. Moss. *Frank. Inst., J.* 205. *pp.* 831–847, *June*, 1928.

Describes an investigation of the effect of the following four variables on the ability to distinguish a certain test object: percentage contrast, brightness, visual angle and time of exposure. The test object consisted of two black rectangles separated by a white space of breadth equal to the breadth of a rectangle. The contrast was varied by the super-position of a variable " veiling " brightness. The exposure was varied by placing the test object on a disc which was rotated at 120 r.p.m., and could be almost instantaneously stopped and started by a magnetic clutch controlled by a switch in the arc of a pendulum, so that the duration of the stoppage could be accurately controlled. It is concluded, as a result of the experiments (given in the form of curves and tables), that within the limits of brightness of 1 to 100 millilamberts, of visual angle of 0·8 to 16·0 minutes, and of exposure of 0·075 to 0·300 sec., the four variables are mutually complementary, *i.e.*, a deficiency in one may be compensated by the augmentation of one or more of the other three. J. W. T. W.

2347. Absorption of Linearly Polarised Infra-Red Radiation by Calcspar (2μ–16μ). F. Matossi. *Zeits. f. Phys.* 48. 9–10. *pp.* 616–623, 1928.

The absorption of the extraordinary ray in the range mentioned was measured for four crystals of thicknesses ranging from 0·09 to 4 mm. The marked absorption region observed at $11\cdot5\,\mu$ corresponds to the fundamental period of the CO_3 group. The characteristic frequency for the ordinary ray at $7\,\mu$, is clearly shown in the absorption curve for the extraordinary ray. Other maxima in the absorption curve are identified with combination frequencies. W. S. S.

2348. Watering Effect. Bordier. *Comptes Rendus,* 186. *pp.* 1443–1445, *May* 21, 1928.

The play of light on watered silk, moiré silk, is due to the production on the retina of circles of diffusion. A. D.

2349. Reflective Power of Some Eutectic Alloys in Relation to their Micro-Structures. G. Ando. *Kyoto Coll. Sci., Mem.* 11. *pp.* 43–84, *March,* 1928.

The investigation was undertaken to gain knowledge of the atomic and molecular constitution of alloys and because of the practical importance of colour. The reflecting power was determined photographically by a comparison of the spectra with the light reflected from the sample and that direct from a tungsten lamp. The results obtained for alloys of Ag-Cu, Cu-Cd, Bi-Cd and Bi-Sn are tabulated and graphs drawn between reflecting power and composition of the alloy and the three dimensional relation between reflecting power, wave-length and composition of the alloy. It was found that the interior of the metal and the surface were substantially the same, the crystallising direction affects reflection inappreciably, and polarisation effects were negligible. In the cases tested a minimum reflecting power was found at the eutectic point, excepting where the reflecting powers between the two components are considerably different. In this latter case the minimum deviates to the side of the weaker component. The results indicate that the roughness of the surface is not the real cause of the minimum reflection, but that the absorption or scattering due to the fine structure of the eutectic is really the principal cause.

R. S. R.

2350. Quantitative Determination of the Degree of Tarnishing of a Metallic Surface by its Reflective Power. G. Ando. *Kyoto Coll. Sci., Mem.* 11. *pp.* 85–93, *March,* 1928.

The principle employed is given in a former paper [see preceding Abstract]. Alloys of Cu and Ag, Cu and Sn, Cu and Cd, Sn and Cd, Bi and Cd, and Bi and Sn were used and their reflecting powers measured directly after polishing. They were then left for 24 hours in a room containing specified quantities of moisture and CO_2, when their diminished reflecting powers were found. The ratio gives the degree of tarnishing. Numerical data and graphs are given. It was concluded that (1) the degree of tarnishing is always specific with respect to a corresponding wave-length, but shows some regularity in each system of alloys; (2) with pure metals the tendency of tarnishing is different from those of their alloys; and (3) by comparing the values of the reflective powers of a sample, when polished and tarnished, for any wave-length, the change of colour of a metallic surface may be determined. R. S. R.

2351. Optical Examination of Substances of Powder- or Fibre-Structure. G. P. Woronkoff and G. I. Pokrowski. *Kolloid Zeits.* 45. *pp.* 1–7, *May,* 1928.

The diffused reflection from an optically heterogeneous body is caused by the many deflections which light rays undergo in the body owing to reflection, diffraction, refraction and total reflection. If ϕ is the angle by which an elementary ray is deflected from its path, and $Jd\phi$ the intensity of the deflected ray, then the mean angle of deflection will be $\Theta = \int_0^{2\pi} \phi J d\phi \Big/ \int_0^{2\pi} J d\phi$. For two bodies having the same absorptive power, but different powers of reflection, the relation holds: $\Theta_1/\Theta_2 = \log J_1/\log J_2$. The shares of the mechanisms of deflecting the ray can be deduced by measuring the J for the same substance impregnated with different media. The body is placed in a shallow basin and strongly illuminated normally, and the intensity J is determined with a König-Martens spectrophotometer. Experiments are made with chalk (particles of 1 mm. or less), powdered glass, powdered mica, talcum and layers of filter paper, impregnated with air (reference medium J_0), water, glycerin, anise oil and carbon disulphide; the $\log J/\log J_0$ are plotted as ordinates against the refractive index for four wave-lengths from 520 to 650 $m\mu$. The same experiments are made with silk fibres suspended in the media mentioned and others. In the case of mica, reflection alone seemed to be of influence; diffraction was observed only with the glass and filter paper. H. B.

2352. Cause and Removal of Certain Heterogeneities in Glass. L. W. Tilton, A. N. Finn and A. Q. Tool. *Bureau of Standards, Sci. Papers No.* 572. *pp.* 719–736, 1928.

Examination of six samples of barium flint lens blanks showed deviations in refractive index (n), with a maximum of 37×10^{-6}. The birefringence did not amount to more than one millimicron per cm. of glass path, and consequently strain or difference in chemical composition was not the cause. The blanks were annealed in a furnace which provided good heat-conducting material around the glass, and precautions were employed to reduce furnace temperature gradients. The blanks were heated to a temperature predetermined by considerations of the expansion coefficient and the heating curve, and the differential effects of previous heating were thus removed. The cooling was not too rapid, and was to a predetermined temperature at which the initial physico-chemical conditions were re-established after a sufficient heating-time. The maximum deviation in n was then 12×10^{-6}. A second and more thorough annealing reduced the maximum deviation o 3×10^{-6}. The importance of removal of temperature gradients in the furnace when annealing is especially emphasised. R. S. R.

2353. Optical Glasses. J. P. Lagrula. *Rev. d'Optique*, 7. *pp.* 137–172, *April*, 1928.

With a view to an application in instrumental astronomy, the author studies various optical glasses with respect to two empirical correlations, *viz.*, $n = f(d,\lambda)$ and $\epsilon = \phi(d,\lambda,h)$, where λ is the wave-length, d is the density of the glass, h is the coefficient of dilatation, n is the index of refraction, and ϵ the coefficient of variation of n with temperature. He establishes numerically the required formulæ in accordance with the data of observation, and using a minimum number of parameters. He retains the essential physical characteristics of the leading classical formulæ, long recognised as unusable in their literal form; and he has relied on Pulfrich and Pockels' experimental principle of the double effect of temperature on the index of refraction through dilatation, and also through an increased absorption of the shorter wave-lengths. A. D.

2354. Eyepiece Providing Rotation of the Images in the Field of a Telescope. M. Hamy. *Bull. Astronomique,* 5. 5. *pp.* 375–377, 1928.

Former arrangements of a rectangular total reflecting prism for rotating the image introduced difficulties, since the image had to be viewed from such a distance that much of the light was lost. The author uses a device consisting of two lenses of equal focal length placed at a distance apart equal to twice the focal length and providing rotation by having a rectangular total reflecting prism between the lenses. The optical axis of the lens system is parallel to the hypotenuse of the prism and perpendicular to its refracting edge, and is at such a distance from the hypotenuse that no lateral displacement of the image occurs in passing through the prism. The lenses have a focal length of 45 mm. and a diameter of 8 mm.

R. S. R.

2355. Theodolites for Pilot Balloons. H. Fuss. *Zeits. Instrumentenk.* 48. *pp.* 228–234, *May,* 1928.

Criticises Tetens' new form of theodolite (with principal axis in the horizontal plane) and discusses theoretically the accuracy attainable under given conditions. The author considers that the field of usefulness of such instruments is confined to cases in which low precision and a comparatively slow rate of observation are all that is required. J. W. T. W.

2356. New Spectroscopic Demonstrator for the Exhibition of Emission, Continuous and Absorption Spectra. H. T. Stetson and H. W. Geromanos. *J.O.S.A. and R.S.I.* 16. *pp.* 293–294, *April,* 1928.

2357. Quarter-Undulation Mica Plates. Rabinovitch. *Comptes Rendus,* 186. *pp.* 1432–1433, *May* 21, 1928.

Discusses the conditions for accurate estimation of these. He remarks that in Chaumont's method (*Ann. de Physique,* 4. p. 200, 1915) the errors are considerable unless the compensator is exactly oriented; he replaces Chaumont's compensator by a Fresnel parallelopipedon. A. D.

2358. "Absolute" Hartmann Test. R. Kingslake. *Optical Soc., Trans.* 29. *pp.* 133–140; *Disc.,* 141, 1927–1928.

According to the ordinary methods of performing the Hartmann test, the assumption is made that all the rays cross the optical axis. As a matter of fact, this is very far from the truth, especially in the case of the large astronomical objectives and mirrors to which the Hartmann test is most generally applied. In the present paper a brief description is given of a modified test in which each "ray" is treated on its own merits and its absolute deviation from the ideal path is determined in both magnitude and direction. This method, incidentally, leads at once to the well-known criterion "T" of Hartmann, which is now generally adopted in the comparison of large telescopes. AUTHOR.

2359. Studies in Laminar Diffraction. Part II. Laminar Boundaries in Mica. I. R. Rao. *Indian Journ. Phys.* 2. *pp.* 365–375, *March,* 1928.

Sheet mica when split unevenly leaves fine hair-like and sometimes irregular lines or striæ which are really abrupt discontinuities in thickness. The thickness of the single striæ may be $2 - 3 \times \lambda_{Na}$ and of multiple striæ $5 - 10 \times \lambda_{Na}$. In an examination of these striæ it was found that

the striæ diffract light through large angles, the light being in general intensively coloured while the colour and intensity effects are unsymmetrical on either side of the incident light. The light diffracted by single striæ is polarised, the polarisation increasing gradually with increasing angle of diffraction. The electric vibration is stronger parallel to the stria on the thinner side and perpendicular to it on the thicker, as for diffraction by sharp metallic edges. Edges of thin transparent mica laminæ exhibit similar intensity colour and polarisation effects. Asymmetry of diffraction is greater with multiple striæ, the colour and polarisation effects are feebler but the intensity is greater. Colours at small angles with multiple striæ are better studied under the Foucault test. Some striæ with echelon-like structures are found to show colours up to large angles of diffraction.
R. S. R.

2360. Light Scattering at Critical Opalescence. Y. Rocard and M. Ponte. *Nature*, 121. *p.* 746, *May* 12, 1928.

Ornstein and Zernicke obtained a formula for light scattering [see Abstract 976 (1927)] at 90° of the incident beam. The authors have generalised this expression for a direction of which the angle with the incident beam is θ and so find

$$i = \frac{4\pi^2\mu^2\left(\frac{\partial\mu}{\partial v}\right)^2}{\lambda^4} \cdot \frac{\frac{RT}{N} \cdot v}{-\frac{\partial p}{\partial v} + \frac{8\pi^2}{3} \cdot \frac{RT}{v^2}\left(\frac{\epsilon\mu \sin^2\frac{\theta}{2}}{\lambda}\right)^2}.$$

From this the following deductions are obtained; (1) By integration of the scattered light in all directions at the point of critical opalescence, an infinite absorption coefficient is obtained; (2) observing the same part of the beam in directions θ and $180 - \theta$, the ratio of the brightnesses would be $1/\tan^2\frac{\theta}{2}$, *i.e.*, 7 or 8 for θ near 40° (instead of 1 as in the ordinary theory of scattering), and (3) when near the critical point $-\partial p/\partial v$ is not zero and, if the incident beam is white, the scattered light in the direction θ (between 0° and 90°) ought to be bluer than that scattered at $180° - \theta$. The last two deductions were tested experimentally, but the theory was not confirmed. It is considered that the theory fails in supposing that the classical theory of fluctuations in density is valid for big volumes but not for small ones, and particularly that the mean square of the fluctuations might become infinite in a big volume but not in a small one. R. S. R.

2361. Photophoresis in Liquids. S. Ray. *Kolloid Zeits.* 45. *pp.* 7–9, *May*, 1928.

Using the term photophoresis for the motion of small particles, both away from the source of light (positive light pressure) and towards the light (the unexplained negative light pressure of Ehrenhaft [see Abstract 1085 (1918)]), the author describes experiments on the motion of particles in liquids. He first observed that the cement used for joining glass windows was streaming in the water (towards the light), and he studied the effect in emulsions. The direction of streaming is always parallel to the beam of the arc lamp, and independent of the shape of the cell, but may be radial close to the walls of the cell. The movement may be positive or negative, and may change for the same substance in the course of an experiment; it is the same in emulsions of oil in water as in emulsions of water in oil. Gas evolution disturbs the phenomena in sulphur suspensions prepared by precipitating sodium thiosulphate with sulphuric acid. The movement becomes slower in the course of time. H. B.

2362. Calculation of the Rotatory Power of Quartz. R. de Mallemann. *Comptes Rendus,* 186. *pp.* 1046–1048, *April* 16, 1928.

The value calculated on the lines of the preceding paper [see Abstract 1893 (1928)] is 30°/mm., as compared with the experimental value 25·5°/mm. If the birefringence were taken as $2\cdot 2 \times 10^{-8}$ instead of $2\cdot 3 \times 10^{-8}$ the agreement would be almost exact. T. M. L.

2363. Beats Produced by the Scattering of Visible or Ultra-Violet Light from Anisotropic Molecules in Rotation and Vibration. J. Cabannes. *Comptes Rendus,* 186. *pp.* 1201–1202, *April* 30, 1928.

Raman has shown that the light scattered from a pure liquid includes new radiations, in addition to the incident radiation. This is explained by the phenomenon of " optical beats " which the author predicted in 1924, but has not been able to demonstrate hitherto. T. M. L.

2364. Photokymograph. W. Miles. *J.O.S.A. and R.S.I.* 16. *pp.* 283–286, *April,* 1928.

Description of the old No. 5 Cirkut Camera (Eastman Kodak Co., U.S.A.—no longer made) and of certain modifications thereon. Its merits, when so modified, when used as a photokymograph for recording deflected beams of light or moving shadows in a light field. A. D.

2365. Photographic Blackening by the Light from Electric Sparks. (Miss) M. Hanot and H. Guillemet. *Comptes Rendus,* 186. *pp.* 1048–1050, *April* 16, 1928.

Although a direct comparison of luminous intensity cannot be made, the blackening of a photographic plate proceeds according to the same law, whether the light is from a continuous source or from a series of sparks. The measurements were made in the blue region of the spectrum, but the nature of the spark spectrum does not appear to be specified. T. M. L.

2366. Sensitising of Ag-Halide Emulsions. S. E. Sheppard and H. Crouch. *J. Phys. Chem.* 32. *pp.* 751–762, *May,* 1928. *Phot. J.* 68. *pp.* 273–280, *June,* 1928.

An elaborate investigation of the question, how much dye is attached to silver halide and what is the nature of the combination. Various provisional hypotheses as to the nature of the adsorption are discussed. A. D.

2367. Ballistic Theory of Radiation. G. Giorgi. *Accad. Lincei, Atti,* 6. *pp.* 261–267, *Nov.* 6, 1927.

A discussion of the ballistic theory of radiation and the consequent Doppler effect of acceleration. The discrimination between the opposing theories is considered, and it is concluded that such an effect would be a conclusive argument in favour of neither theory. A. Wh.

2368. A New Radiation. C. V. Raman. *Indian Journ. Phys.* 2. *pp.* 387–398, *March,* 1928.

Experiments in 1921 and 1922 showed that the depolarisation of the light transversely scattered by carefully purified liquids increased very markedly when a violet filter was placed in the path of the incident light. Further work by K. R. Ramanathan in 1923 seemed to show that the effect was a species of " weak fluorescence," but S. Venkateswaran showed later that the visible radiation excited in glycerine by ultra-violet radiation is strongly polarised. The present author has undertaken an experimental re-examination of the subject, and has demonstrated that the phenomenon is quite distinct from fluorescence in that it is of a different order of intensity and is strongly polarised. It has also been discovered that the spectrum of the new radiation contains lines not present in the spectrum of the incident light. The phenomenon appears to be given by liquids and gases and also by some solids. As a tentative explanation it is suggested that the incident quantum of radiation is partially absorbed by the molecule, and that the unabsorbed part is scattered, such a possibility being already contemplated in the Kramers-Heisenberg theory of dispersion. Photographs illustrating the effect are given. T. B.

2369. Classical Theory of Light. Part I. K. K. Darrow. *Bell System Techn. J.* 7. *pp.* 281–320, *April*, 1928.

The author gives a general discussion of the notion of wave-motion based on Kirchhoff's theorem, which is expounded in detail. A number of wave diffraction problems are solved by the aid of the theorem. W. S. S.

2370. Theory of Light: Energy, Coherence and Supplementary Fringes. F. Wolfers. *Comptes Rendus*, 186. *pp.* 1198–1201, *April* 30, 1928.

The formation of supplementary fringes is cited as the first clear example of a phenomenon which cannot be explained either by an undulatory or by a quantum theory, but which must be considered simultaneously from both points of view. T. M. L.

2371. Light Quanta and Wave Mechanics. J. C. Slater. *Phys. Rev.* 31. *pp.* 895–899, *May*, 1928.

Light quanta are treated by wave mechanics by analogy with electrons. It is shown that their wave equation is the ordinary optical wave equation. Heisenberg's principle of indeterminateness becomes a description of diffraction. In problems in which localisation of quanta is found experimentally, wave packets are to be set up; these are applied to the experiments of Bothe and Geiger, and of Compton. The paths of quanta coincide with the rays of geometrical optics, with a deviation of the error in geometrical optics; by the principle of indeterminateness, more accurate laws for the paths are neither necessary nor possible. AUTHOR.

2372. Explanation of certain Spectral Properties on the Quantum Mechanics of Rotating Electrons. Part II. J. v. Neumann and E. Wigner. *Zeits. f. Phys.* 49. 1–2. *pp.* 73–94, 1928.

By means of the results of Part I [see Abstract 1260 (1928)] the structural principles of series spectra, the rules for the inner and magnetic quantum number, and the quadratic Stark effect are now mathematically investigated. H. H. Ho.

2373. Spectrum of AgII. K. Majumdar. *Indian Journ. Phys.* 2. *pp.* 257–266, *Jan.*, 1928.

Terms in the spectrum of AgII are deduced on the basis of constant frequency differences and intensities. The low term I'So is not found, but it is deduced that its lines will lie in the Schumann region. A. C. M.

2374. Behaviour of Hydrogen and Mercury at the Electrode Surfaces of Spectrum Tubes. M. C. Johnson. *Roy. Soc., Proc.* 118. *pp.* 695–708, *April* 2, 1928.

The spectrum of a gas is known to be capable of being profoundly modified by the presence of small quantities of a foreign gas, and the modification is brought about by many processes. To investigate this more narrowly, the author studies the emission of a Balmer line brought about by the neutralisation of positive rays in hydrogen, the foreign gas being mercury. (1) The Doppler effect was observed of hydrogen positive rays, comparing the intensities of the "rest" component and the "moving" component of H_β. This compares the proportion of emission of H_β due to impact with that due to neutralisation at the kathode. It was found that slight contamination by mercury vapour considerably increased the ratio of intensity of the "rest" to the "moving" component. (2) To compare the effect of the electrode surfaces, electrodes of Al and of Ni were used. With the latter, a partial pressure of mercury larger by 100 % is required before the Hg lines appear. This effect was lessened if the tubes were gas-connected. (3) By plotting current-potential curves, for two tubes in which the electrodes were Al and Ni respectively, but otherwise identical, it is shown that the resistance change is the same for the two tubes containing hydrogen pure or contaminated. (4) In badly contaminated tubes the gradual saturation of the absorbing sodium or silver employed, and the gradual weakening of the Hg spectrum at the electrodes were functions of the time during discharge, not of the time intervals between. (5) A solid Hg kathode can be made to disintegrate electrically in a way distinct from its thermal evaporation. But the disintegration layer from a contaminated Al kathode is of Al, and neither due to thermal nor electrical disintegration of the contaminating Hg. The author concludes that the admission of gas liable to multiple ionisation leads to a more violent bombardment of the kathode. This probably breaks down the protective oxygen layer on the Al, and allows escape of gas from the metal structure. This weakens the Al and allows increased sputtering. The Hg in combination or in solution on the kathode is evaporated, and contributes largely to the spectrum, in spite of its low partial pressure, because of its favourable ionisation potential.

A. C. M.

2375. Intensity Measurements in the Secondary Spectrum of Hydrogen. L. S. Ornstein, W. Kapuscinski and (Miss) J. G. Eymers. *Roy. Soc., Proc.* 119. *pp.* 83–91, *May* 1, 1928.

Using the Utrecht method of intensity measurement for the region 4500–4900 Å. the intensities in the secondary spectrum of hydrogen are measured and composed with the values given by McLennan and others. It is shown that the photographic plate is of very rapidly variable sensitivity in this region, and hence the relationship between density and intensity more complex than contemplated by McLennan.

W. V. M.

2376. Absolute Intensity of the Mercury Line 2537. P. Kunze. *Ann. d. Physik*, 85. 8. *pp.* 1013–1057, *May* 24, 1928.

The absolute intensity of a resonance line can be obtained by the Puccianti method or by measuring the absorption at a given vapour pressure. The author has measured the selective absorption of the resonance light produced by passing light from a mercury lamp through a monochromator, so as to separate the above line, and into a specially designed resonance chamber containing mercury vapour which was heated in an oven. The resonance light passed out at right angles to the direction of the incident light, and passed through a quartz glass absorption chamber into a photoelectric cell by means of which the intensity of the original resonance light, and of the same light after absorption, could be measured. The theory of the method is considered in detail, and a number of necessary corrections are taken into account. The final value 5·78 ± 0·13 was obtained for k_{20}, the absolute intensity when the temperature of the absorption chamber containing saturated mercury vapour is 20° C.; v. Malinowski found $k = 3·11$; Orthmann, $k_{20} = 3·15$; Goos and Meyer, $k_{20} = 2·97$; and Schein, $k_{20} = 3·77$. The differences between these values and that of the author are probably due to the fact that in obtaining the latter special arrangements were made to obtain the pure phenomenon and to make all necessary corrections. Füchtbauer, Joos and Dinkelacker, using the method depending on the broadening of the absorption line by pressure, found $k_{20} = 26·8$. This was due to their measurements having been made on the unresolved line. When the effect of the fine structure of the line is taken into account their result can be shown to agree with that of the author. H. N. A.

2377. Voltage-Intensity Relations in the Mercury Spectrum. W. D. Crozier. *Phys. Rev.* 31. *pp.* 800–811, *May*, 1928.

Voltage-intensity curves have been obtained for twenty lines of the mercury spectrum when excited by electron impact. The range of accelerating voltage was from excitation to 50 volts, the discharge tube being designed to eliminate most of the disturbance due to positive ion formation. The components of four of the triplet groups were resolved and investigated separately. No significant change appears in the number of atoms in a given energy state as the ionisation potential is passed. The components of each of the *d*D groups of energy levels are excited at practically the same voltage but have quite different excitation functions. The excitation functions for d_1, d_3, and *s* levels and for the $2p_2$ level appear to be similar in form and to have sharp maxima within a few volts of the excitation voltage. The excitation functions for d_2 and D levels also appear similar, increasing uniformly to 30 or 40 volts where they have broad maxima. The voltage-intensity characteristics of lines originating in transitions down from the same initial level agree in type but sometimes show certain differences in shape. It appears that the probability of different transitions down from a given energy state may not be independent of the way in which this state is excited. There is evidence that a large number of excitations of $2p_2$ by transitions down from higher levels are not followed by $1S - 2p_2$ transitions. AUTHOR.

2378. Quenching of Mercury Resonance Radiation by Foreign Gases. M. W. Zemansky. *Phys. Rev.* 31. *pp.* 812–821, *May*, 1928.

Milne's theory of the diffusion of imprisoned resonance radiation is applied to Stuart's experiments on the quenching of Hg resonance radiation by foreign gases, and expressions obtained for n_2, the number of excited Hg atoms per c.c., and J, the quenching, in terms of *k*, the number of impacts of the second kind per sec. per excited atom. Stuart's experimentally determined values of J are used to give the relation between *k* and the pressure of the foreign gas, and the result is obtained that the number of impacts of the second kind per sec. per excited atom is not a constant fraction of the total number of collisions. The total number of impacts of the second kind per c.c. is calculated and taken as the reaction velocity, and upon plotting against the pressure it is shown that the reaction velocity varies as the 0·6 power of the pressure for all the foreign gases. It is shown how these results can be explained on the theory that impacts between excited Hg atoms and foreign gas molecules give rise to metastable Hg atoms, which diffuse to the incident wall and meet there adsorbed foreign gas molecules to which they give up their energy. This theory is also capable of explaining the behaviour of a large quantity of inert gas on the dissociation of hydrogen and oxygen by excited Hg atoms.

AUTHOR.

2379. Chemiluminescence of Alkali Metals and Tin Halides. M. Polányi and G. Schay. *Zeits. f. Phys.* 47. 11–12. *pp.* 814–818, 1928.

Highly attenuated flames having continuous spectra can be produced by the reaction of alkali-metal vapours with $SnCl_4$, $SnBr_4$, and SnI_4. This allowed the calculation of the heat of combination of the 4th and 3rd Cl atom in $SnCl_4$. Emission of light due to combination was ruled out by subsidiary experiments, and it is concluded that at the time of the reaction a partition of the energy occurs by which varying amounts of kinetic energy are given to the reaction products, the rest of the energy appearing as light. A. C. M.

2380. Effective Radius of Action of Atoms in Collision. W. Schütz. *Zeits. f. Phys.* 48. 1–2. *pp.* 67–72, 1928.

In a former paper [see Abstract 1030 (1926)] the author has put forward evidence that the effective radius of action of atoms must be considered to be increased considerably above the gas-kinetic value when collisions of atoms of the same kind are in question, and the phenomenon was compared with the behaviour of two tuning forks. The high "sensibility-factor" was attributed to resonance. In the present paper attention is drawn to the confirmation implicit in publications recently by Orthmann and Pringsheim [see Abstract 919 (1928)] and by V. v. Keussler [see Abstract 2285 (1927)]. In addition, some criticisms are considered, and practical consequences arising from the theory are also suggested.

A. C. M.

2381. Absolute Intensity Measurements on a Sodium Flame. L. S. Ornstein and E. F. M. van der Held. *Ann. d. Physik,* 85. 7. *pp.* 953–960, *May* 2, 1928.

A description of a determination of the number of quanta sent out per atom per second from a sodium flame under carefully controlled conditions. The method used is essentially that normally used in Utrecht, photographic densities being measured and the emission determined absolutely in comparison to the measured green line of a mercury arc in quartz. It is found that a Na atom at 1970 Å. sends out 250 quanta per second. The time during which the electron remains in the excited state as deduced using Einstein's formula [see Abstract 654 (1917)], is found to be $5 \cdot 10^{-8}$ sec. W. V. M.

2382. Continuous Absorption in Sodium Vapour. B. Trumpy. *Zeits. f. Phys.* 47. 11–12. *pp.* 804–813, 1928.

The continuous absorption coefficient of sodium vapour decreases rapidly from its value at the limit of the principal series as the wave-length diminishes, and at about 2300 Å.U. has half the value at the principal-series limit. This is compared with the theory of Sugiura. At the series-limit the absorption goes over continuously into the line absorption; an apparent decrease in the absorption as the wave-length increases is ascribed to the deficient resolving power of the spectrograph. At high temperatures a continuous absorption is observed between the principal series lines. A. C. M.

2383. Fluorescence Spectrum of Sodium Vapour in the Vicinity of the D Lines. R. W. Wood and E. L. Kinsey. *Phys. Rev.* 31. *pp.* 793–799, *May,* 1928.

When sodium vapour is mixed with hydrogen, air or nitrogen at pressures between 2 and 3 mm. it is possible to excite the D lines by radiation in the region 5100 to 5250 Å. Since this radiation is absorbed only by the sodium molecules it is probable that the primary act is the excitation of the molecule. The excited molecule may then cause the D line emission by collisions of the second kind with atoms, or by dissociating, either spontaneously or as a result of collisions with the foreign gas, into a normal and an excited atom. To distinguish between these processes further experiments are necessary. A band-group formerly studied by one of us was found to appear in the yellow region of the fluorescence spectrum under white light stimulation when nitrogen or hydrogen was present at a pressure of 6 ± 1 mm., and indications are that they are excited by light of their own wave-length. The experiments also verify completely the older work of Wood and Galt on a kathode-ray spectrum. Photographs of the absorption spectrum and other considerations indicate that these bands are not the bands ascribed by Barratt and Pringsheim to a sodium-potassium molecule. AUTHORS.

2384. Spark Spectrum of Sodium. S. Frisch. *Zeits. f. Phys.* 49. 1–2. *pp.* 52–58, 1928.

The spectrum was produced by means of a discharge tube with hollow kathode, in the form of an open cylinder without a slit; it was photographed and measured in the region 4000 to 2500 Å. A number of lines are arranged in a level scheme. De Bruin has showed that in the case of K^+ and argon the ratio $\nu K^+/\nu Ar$ between analogous lines is about 1·95; the author obtains a ratio of about 2·07 between νNa^+ and νNe; other analogies between the two spectra are pointed out. H. N. A.

2385. Anomalous Dispersion in Thallium Vapour. W. K. Prokofjew and the late W. N. Solowiew. *Zeits. f. Phys.* 48. 3–4. *pp.* 276–285, 1928.

The anomalous dispersion in the neighbourhood of the lines 3776 and 5350 of thallium vapour is investigated by means of the hook method. It is found that the ratio of the numbers of the dispersion centres changes with the temperature in accordance with Boltzmann's law. Also that the probabilities of the spontaneous transitions $2s \rightarrow 2p_1$ and $2s \rightarrow 2p_2$ are equal. E. E. F. d'A.

2386. Fine Structure of Thallium Lines in the Ultra-Violet. W. Mohammad and S. B. L. Mathur. *Phil. Mag.* 5. *pp.* 1111–1114, *May,* 1928.

Twelve of the lines between 6550 Å. and 2580 Å. have been examined with a quartz Lummer-Gehrcke plate and quartz spectrograph. Details of the structures of these lines are given. F. S.

2387. Shifting of the Wave-Length of Light. S. J. Wawilow. *Zeits. f. Phys.* 48. 7–8. *p.* 600, 1928.

The change in the wave-length of light caused by passage through a Kerr's cell observed by E. Rupp [see Abstract 1282 (1928)] is commented upon by the author, who points out that the broadening of the thallium line observed by Rupp can be interpreted as an example of the Doppler-Michelson principle. J. J. S.

2388. Optical Peculiarities of the Electric Spark. G. I. Pokrowski. *Zeits. f. Phys.* 48. 7–8. *pp.* 586–593, 1928.

The intensity of the light which is emitted by an electric spark is treated as a function of the current strength and the distance apart of the electrodes. Spectral regions with and without lines were investigated theoretically and experimentally, and a good agreement between theory and experiment was obtained. The possibility of a new method for investigating the fine structure of spectral lines is considered. The optical peculiarities of the electric spark can be treated as analogous to those of turbid media, and so the occurrences in the spark as well as the structure of spectral lines can be investigated. J. J. S.

2389. Measurement of Radiation from Tungsten Lamps. H. C. v. Alphen. *Ann. d. Physik,* 85. 8. *pp.* 1058–1088, *May* 24, 1918.

Deals with the photometric and the pyrometric methods of comparing the energy distribution in the spectrum; in the first method real images were formed, with light that could be regarded as almost monochromatic, on the surface of a thermopile with which the energy was measured. A van Cittert double monochromator was employed to separate out beams of light of approximately the same wave-length; the wave-length could be varied by moving the slit between the two halves of the instrument, so that different portions of the spectrum could be examined in turn. Each beam was examined in a spectrograph by means of which its spectrum was photographed. The dispersion curve in the visual region was measured by a visual method. After the necessary corrections were made the distribution curve for the energy intensity in the spectrum agreed pretty well with that deduced from a Wien curve calculated for the temperature T = 1980°. In the determination of the energy distribution by means of temperature measurements with the optical pyrometer, corrections had to be made for the increased brightness of the inner parts of the spiral of the lamp, owing to reflection of light from other parts, other necessary corrections are considered. The final results of the two methods agree satisfactorily. H. N. A.

2390. Spectrochemical Studies of Hydroxyazo Compounds. Part VI. T. Uemura and S. Tabei. *Chem. Soc. Japan, Bull.* 3. *pp.* 105–107, *April*, 1928.

From a consideration of the position of the hydroxyl group with regard to the azo group it is concluded that (1) the *o*-hydroxyl group in hydroxyazo compounds gives rise to two bands in their absorption curves, and (2) the methyl-group shows perhaps no influence upon the shape of the absorption curves of hydroxyazo compounds. R. S. R.

2391. Infra-Red Absorption Spectra of the Halogen Derivatives of Methane. M. A. Easley, L. Fenner and B. J. Spence. *Astrophys. J.* 67. *pp.* 185–194, *April*, 1928.

The infra-red absorption spectra of the halogen derivatives of methane, CH_3I, CH_2Cl_2, CH_2Br_2, CH_2IBr, CH_2I_2, $CHCl_3$, $CHBr_3$, CCl_4, CBr_4, and $CBrCl_3$, were obtained between 0·8 and 3 μ by means of an infra-red spectrometer with the use of a grating with 10,000 lines to the inch. A large number of new bands was discovered, owing to the greater resolution and dispersion obtained by the use of the many-lined grating. It was found that in the region of observation no bands exist for substances which did not have hydrogen in the molecule. For the other substances containing hydrogen there was a similarity of spectra. The bands do not lend themselves to an arrangement in a single series but to probably four series, which may be explained on the basis of four fundamental frequencies of vibration of the molecule. AUTHORS.

2392. Absorption Spectra of Anthracene Derivatives. Part I. E. de B. Barnett, J. W. Cook and T. E. Ellison. *Chem. Soc., J. pp.* 885–890, *April*, 1928.

The effect produced on ten absorption spectrum of anthracene by the substitution of groups is studied. The chief feature of the anthracene absorption spectrum is six bands lying between limits 2600 and 3900 Å.U. approximately. The shift of these bands has been measured for twenty derivatives, and conclusions drawn as to the nature of the binding of the different groups. The absorption curves were obtained by the Hartley method, using the substances in alcoholic solution. A. C. M.

2393. Near Infra-Red Absorption Bands of Some Hydrocarbons. J. Barnes and W. H. Fulweiler. *Am. Chem. Soc., J.* 50. *pp.* 1033–1035, *April*, 1928.

The near infra-red absorption bands of liquid pentane, decane, and tetra-decane were photographed with a grating and prism spectroscope. The bands were found to consist of a doublet and singlet series. The frequencies of the doublet series of the paraffins were lower than those of the doublet series of the benzenes. The frequency difference for the paraffin doublet band at 0·92 μ was 7×10^{12} sec.$^{-1}$, while for the band at 0·75 μ it was 8×10^{12} sec.$^{-1}$. The 0·874 μ band of benzene and the 0·877 μ band of toluene are close doublets with a frequency difference of 3×10^{12} sec.$^{-1}$. F. J. B.

2394. Analysis of Spectra Arising from Quadruply Ionised Tin, SnV. R. C. Gibbs and H. E. White. *Nat. Acad. Sci., Proc.* 14. *pp.* 345–348, *April*, 1928.

Intensities, wave-lengths and frequencies of strong lines in the spectrum of SnV are tabulated and discussed. Terms arising from $4d^95s$ are in the order predicted by Hund's theory. The $^3D_{1,2,3}$ terms have more nearly the interval ratio 2 : 1 than the ratio 2 : 3 required by Landé's rule. J. S. G. T.

2395. Effect of Pressure on the Spectrum of the Iron Arc. H. D. Babcock. *Mt. Wilson Observat. Contrib. No.* 350. *Astrophys. J.* 67. *pp.* 240–261, *April*, 1928.

Pressure effect in the arc spectrum of iron, λ3895–λ6678, for pressures below 1 atmosphere.—For 130 spectral lines (Table II of original paper) observed in arcs considered to be free from pole effect, displacements due to change of pressure are accurately measured with Fabry-Perot interferometers. With the aid of a list of terms and their combinations, the displacements are interpreted as the result of depressions of the terms with increase of pressure (Table III of original paper), high-level terms being much more affected than those of low level, and those of quintet and septet multiplicity more than the triplet terms. Empirical expressions of these relations are developed, which make it possible to predict the pressure effect for both terms and lines. No connection is found between term displacements and azimuthal or inner-quantum numbers.

Discussion of results by Gale and Adams for Fe and Ti.—The observed line displacements (Table II of original paper) are systematically less than those of other observers, but full qualitative agreement is found between the new data and those of Gale and Adams. Their classification of lines according to pressure groups is thus given numerical significance and is shown to have a definite physical basis.

Theories which attribute pressure effect to coupling forces between adjacent similar atoms are found to be inconsistent with the data.

Numerical definition of temperature classification.—Statistical examination of the levels for each temperature class assigned by King in the spectra of Fe, Ti, Sc and Ba shows that in general a progression of one temperature class corresponds to a change of about 0·70 volt in the level of the terms involved. The coefficient for Ca is 0·35 volt. AUTHOR.

2396. Lowest Terms in the Spark Spectrum of Nickel and Copper (NI II and CU II). R. J. Lang. *Phys. Rev.* 31. *pp.* 773–775, *May*, 1928.

The lowest terms $^2D_{2,3}$ in the spark spectrum of nickel (from the state d^9) are found to lie 6884 and 8391 cm.$^{-1}$ below $a^4F'_5$. In the spark spectrum of copper (CuII) the lowest term is $^1S_0(d^{10})$ and lies 21925 cm.$^{-1}$ below a^3D_3. [See also Abstracts 2063 (1927) and 99 (1928).] AUTHOR.

2397. Arc Spectrum of Germanium. C. W. Gartlein. *Phys. Rev.* 31. *pp.* 782–792, *May*, 1928.

The wave-lengths of lines in the germanium arc spectrum have been measured in the region above 1870 Å. with an accuracy of at least 0·03 Å. From these lines the relative energy levels have been determined and transitions corresponding to 73 lines have been identified. In the normal state the germanium atom contains two *p* valence electrons which give rise to the lower levels $^3P'_{012}$, $^1D_2$, $^1S_0$, with $^3P'_0$ lying deepest as predicted by the theory of Hund. The next higher levels arise from the configurations *ps* and *pd*. Data on the persistence of germanium lines were of great value in identification of the levels. At least two members of each of 11 series have been found and approximate limits have been calculated to be 65,300 for $^2P_2$ and 63,600 for $^2P_1$. The first resonance potential is 4·65 volts, and the ionisation potential determined by the limit $^2P_1$ is 7·85 volts. The similarities in the arc spectra of Si, Ge, Sn and Pb are pointed out, and the relative term values for these spectra are brought together in a single diagram. AUTHOR.

2398. Application of the X-Ray Laws to Optical Spectra of Higher Rank and the Classification of GaIV and GeV. J. E. Mack, O. Laporte and R. J. Lang. *Phys. Rev.* 31. *pp.* 748–772, *May*, 1928.

The spectrum of GaIV was photographed by means of a high vacuum spectrograph, and the lines obtained have been classified; the spectrum of GeV could not be obtained with the apparatus employed, but the lines obtained by other observers have been classified, and the two spectra interpreted as members of the isoelectronic series NiI, CuII, ZnIII, GaIV, GeV. The ($3d^9 4s$) and $3d^9 4p$) levels of GaIV and GeV, and a tentative ($3d^{10}$) level for GaIV, have been found by application of the Moseley law, and the two doublet laws of X-ray spectroscopy. Evidence is adduced to show that the $^3D_2$ level behaves in this isoelectronic sequence in a manner contrary to the theory of Hund. Distinctions are drawn between the application of the X-ray laws to X-ray and to optical spectra; X-ray energy levels are ionisation energies of neutral atoms and the first order screening number σ_1 increases with Z; it decreases as Z increases in isoelectronic spectra, the difference may be due to outer screening. The paper is illustrated by a number of tables and graphs, and contains a mass of information as to the theoretical methods employed. H. N. A.

2399. Positions of X-Ray Spectra as Formed by a Diffraction Grating. A. W. Porter. *Phil. Mag.* 5. *pp.* 1067–1071, *May*, 1928.

X-ray spectra are generally treated in the same way as Fraunhofer optical spectra, where the incident light is a parallel beam and is brought to a point or line by a lens. With X-rays the incident beam is always divergent, and the diffracted beam is convergent. The author works out formulæ for correcting the values obtained when calculations are made in the usual manner; assuming nearly grazing incidence the wave-lengths should be multiplied by the factor $1 + 3X^2/(20l_0^2)$, where X is the length of the complete grating, and l_0 is the distance from the centre of the grating to the source, and to the photographic film. A table gives the values of the small corrections for different values of X and l_0. H. N. A.

2400. Luminescence Excited by X-Rays in Colloidal Alkaline Earth Salts. C. H. Boissevain and W. F. Drea. *Phys. Rev.* 31. *pp.* 851–857, *May*, 1928.

The gelatinous precipitates of calcium, strontium and barium fluoride are positive colloids. The precipitates formed in the presence of an excess of calcium, strontium or barium ions luminesce in X-rays. The intensity of luminescence increases after the precipitate has been brought to red heat. The salts that are precipitated in the presence of excess fluoride do not luminesce in X-rays. The positively charged fluorides are changed into negative colloids by washing in dilute alkali; this causes the disappearance of the luminescence. Washing with dilute acid or distilled water is without effect. Colloidal barium sulphate shows a similar behaviour. Calcium tungstate and strontium tungstate are negative colloids; the precipitates formed in the presence of excess tungstate ions fluoresce brightly in X-rays. The precipitates formed in the presence of excess calcium or strontium ions fluoresce very faintly. A table is given showing the extent of the luminescent bands into the ultra-violet. Fluorides that have been heated in a hydrogen atmosphere show a dark discoloration and do not luminesce in X-rays. The presence of impurities diminishes the luminescence of colloidal precipitates. The alkaline earth chlorides and phosphates, calcium and strontium sulphate, and barium tungstate formed only crystalline precipitates that did not luminesce in X-rays. The hypothesis is made that the luminescence of colloidal precipitates is due to a thin layer of metallic oxide which is formed from the double layer of ions that is adsorbed on the surface of the colloidal particles. AUTHORS.

2401. X-Ray Examination of Saturated Dicarboxylic Acids and Amides of the Fatty Acid Series. E. Henderson. *Roy. Soc. Edinburgh, Proc.* 48. 1. *pp.* 20–27, 1927–1928.

Several additional members of the series of *normal saturated dicarboxylic acids* have been investigated by X-rays, and the results are in agreement with the conclusions arrived at in an earlier paper. In the series of *mono- and di-alkyl malonic acids*, successive reflection planes are separated by the length of one molecule. The series of *fatty acid amides* closely resembles that of the fatty acids themselves. The cleavage planes are separated by the length of two molecules oriented in opposite directions. A. B. W.

2402. X-Ray Diffraction in Liquid CCl_4. C. M. Sogani. *Indian Journ. Phys.* 2. *pp.* 377–386, *March*, 1928.

The diffraction in liquid CCl_4 is studied with CuKα rays. The pattern shows a sharp inner and a diffuse second ring separated by a very clear space. The sharpness of the inner ring is compatible with the highly symmetrical tetrahedric shape of the molecule. Two alternative explanations are suggested for the second ring: (1) It may be a second order effect, which becomes important in this case on account of the compact shape of the molecule; (2) it may be due to the shape of the molecular F-curve. The former appears preferable since mercury and argon, which are monatomic, also show a similar second ring. Analogies are pointed out between X-ray diffraction in liquids with spherical molecular and the optical haloes observed with homogeneous chromatic emulsions. [See also Abstracts 2926 (1927) and 372 (1928).] A. D.

2403. Relation between Chemical Constitution and X-Ray Diffraction in Liquids. Part I. Mono- and Disubstituted Benzene Derivatives. P. Krishnamurti. *Indian Journ. Phys.* 2. *pp.* 355–364, *March*, 1928.

Examination of a number of ortho disubstituted benzene derivatives shows that two substituents in the ortho position invariably give rise to two distinct rings clearly separated from each other. In the ortho substituted compounds, the outer ring increases in brightness as the sizes of the substituting groups are increased. In the meta compounds examined, it is found that (*a*) two rings are present, (*b*) the two rings have shrunk in size slightly as compared with the ortho, (*c*) and that the outer ring increases in brightness relatively to the inner more than in the corresponding ortho compounds. The para substituted compounds do not show the presence of two rings. Only one broad ring is obtained with diffuses outwards. Benzene derivatives with a single long side chain show a similarity to the corresponding aliphatic derivative. Ethyl benzoate is somewhat similar to acetic acid since both of them show a faint inner ring. A. B. W.

2404. Hemihedry of Zinc Blende and X-Ray Reflection. S. Nishikawa and K. Matukawa. *Imp. Acad. Tokyo, Proc.* 4. *pp.* 96–97, *March*, 1928. *In English.*

An experiment was carried out to detect, if possible, any difference in the intensity of reflection from a pair of hemihedral planes (1 1 1) and $(\bar{1}\,\bar{1}\,\bar{1})$ of zinc blende, using the tungsten L-radiation, of which the spectral lines are distributed over a range across the K critical absorption limit of zinc atoms. It was found that the relative intensities of the β_1, β_2 and β_4 lines were different in the two photograms corresponding to (1 1 1) and

$(\bar{1}\bar{1}\bar{1})$ reflections. Further experiments are in progress to detect how far this difference is due to phase retardation. W. C. S. P.

2405. Absorption and Dispersion in X-Ray Spectra. R. de L. Kronig and H. A. Kramers. *Zeits. f. Phys.* 48. 3–4. *pp.* 174–179, 1928.

The total strength of oscillators attributable to the continuous absorption bands in X-ray spectra in order to yield the observed absorption and dispersion is, in general, different from the number of the electrons in the shell to which the absorption band belongs. The authors explain this on Pauli's principle. E. E. F. d'A.

2406. Broadening of the Debye-Scherrer Lines in Cold-Worked Tungsten Wires and Bands, as a Function of the Temperature and Duration of Glowing. A. E. van Arkel and W. G. Burgers. *Zeits. f. Phys.* 48. 9–10. *pp.* 690–702, 1928.

The photographs of the copper Kα doublet were measured photometrically, after different heat treatments, care being taken to make them as far as possible under identical conditions. The ratio U between the intensity at the maximum of the stronger line (a_1), and that at the minimum between the two lines, was taken as a measure of the sharpness of the doublet. U was determined for the doublet from (321) in the case of wires, and for that from (400) in the case of the thin strips of tungsten. The sharpness quickly increases when the metal is glowed, and when the temperature is not so high as to cause recrystallisation U reaches a nearly constant end value, which increases with the temperature. The authors consider that the experiments show that the broadening of the lines caused by cold working is due to distortions produced in the lattice, which are partially removed by subsequent heating, the extent to which this takes place depending on the temperature. H. N. A.

2407. K-Absorption Edges of Potassium and Chlorine in Various Compounds. J. M. Nuttall. *Phys. Rev.* 31. *pp.* 742–747, *May*, 1928.

A vacuum spectrometer of the Siegbahn type was employed in the examination of the absorption of X-rays by the potassium in sylvine, orthoclase, lepidomelane and phlogopite; in the first two the absorption was in the reflecting crystal itself, in the others in thin sheets of the substance in the path of the beam, which was dispersed by a calcite crystal. The chlorine of the sylvine gave an excellent Cl K-absorption edge. The fine structure of the potassium edge is very similar in the four crystals, and as many as five secondary edges were observed, extending from 3429 to 3365 X.U., over a range of about 67 volts; the fine structure of the chlorine edge extended from 4383 to 4341 X.U., or about 27 volts. Kossel's explanation of the fine structure, as being due to the ejected electrons stopping in the various unoccupied orbits in the outer part of the atom, cannot apply to the secondary edges which are remote from the main edge, and it seems necessary to assume that there is double ionisation of the atoms. H. N. A.

2408. Direct and Indirect Characteristic X-Rays: Their Ratio as a Function of Kathode-Ray Energy. D. L. Webster. *Nat. Acad. Sci., Proc.* 14. *pp.* 330–339, *April*, 1928.

In a previous paper [see Abstract 3134 (1927)] the direct process was defined as the ejection of K-electrons from atoms by impact of the kathode ray on those atoms and their resulting reorganisation, and the indirect process as the ejection by photoelectric effect of continuous-spectrum X-rays excited by kathode rays in other atoms. The present paper studies experimentally whether these processes both occur to any noticeable extent. The value of the ratio for silver is found to be almost constant, the data giving 1·83 at 35 kV, and 1·96 at 80 kV, a variation insufficient to vitiate current comparisons of observed line intensities with theories. H. H. Ho.

2409. K-Electron Ionisation by Direct Impact of Kathode Rays. D. L. Webster. *Nat. Acad. Sci., Proc.* 14. *pp.* 339–344, *April*, 1928.

The assumptions underlying the theory of indirect K-ionisation are tested and found to give results of the right order, though apparently not strictly accurate. The probability of direct K-ionisation by a kathode ray in silver is found to be 0·9 times the probability of an equivalent quantum emission in the continuous spectrum, a ratio constant with change of voltage and holding therefore not only for thick but for infinitely thin targets also. The absolute probability of direct K-ionisation has been estimated, with large limits of error, and the results agree with Thomas's theory. It seems probable that the process of direct ionisation is not usually an internal photoelectric effect, but rather a process of repulsion between electrons much like ordinary electrostatic repulsion. H. H. Ho.

2410. Excitation of Soft X-Rays. Part II. O. W. Richardson and F. C. Chalklin. *Roy. Soc., Proc.* 119. *pp.* 60–83, *May* 1, 1928.

The paper is a continuation of previous work [see Abstract 1365 (1926)]. The apparatus has been made more sensitive and the discontinuities in the ionisation curves for Fe investigated over the whole region to 720 volts, filling in the gaps previously left. Tables of the critical potentials are given. The existence of a series of voltages related by a Rydberg type of law $V(n) = A - b/n^2$ as suggested by Rollefson is considered, and it is thought that for Ni_1 and Co the agreement with the experimental data is good but less decisive and possibly unfavourable in the case of Cu. The results, more particularly the numerical constants, are discussed in terms of atomic structures. Experiments with deposited films of metals are used to control the results. Some of the critical potentials found previously have to be reconsidered, in some cases the origin of the critical values being very difficult to assign. W. V. M.

2411. Apparent Irregularities in Experiments with Heterogeneous X-Ray Beams, with Special Reference to the J-Phenomenon. R. T. Dunbar. *Phil. Mag.* 5. *pp.* 962–989, *May*, 1928. *Supplement.*

Two experiments are described which aimed at discovering the J-discontinuities in the absorption of scattered X-radiation (heterogeneous). The results were negative. A discussion is given of the results obtained by Barkla and his collaborators. It is shown that much of the irregularity they observe is only apparent, that it possibly arises largely, if not altogether, from the assumption that a heterogeneous beam should give sufficiently nearly the same results as a homogeneous beam, the latter having an absorption-coefficient equal to the half-value absorption-coefficient of the former. The progressive absorption method, for instance, frequently used by them to test for the Compton effect, is not suitable unless the radiation is homogeneous, or nearly so; for very heterogeneous beams it is unable to distinguish between classical and Compton scattering. It is suggested that the pronounced irregularities observed by the above authors are associated with the varying amounts of extremely soft radiation which may succeed in reaching the electroscopes. A. B. W.

2412. Certain Multiplets in the Spectra of Cadmium III and Indium IV. R. C. Gibbs and H. E. White. *Phys. Rev.* 31. *pp.* 776–781, *May*, 1928. *Paper read before the Am. Phys. Soc., Feb.*, 1928.

Terms and related wave-lengths and frequencies arising from the configuration d^{10}, d^9s, d^9p of CdIII and InIV.—Guided by the transitions from ^{3}PDF, ^{1}PDF, ($4d^95p$) to ^{3}D, ^{1}D ($4d^95s$) already determined for PdI and AgII the corresponding lines have been identified in the spectra of CdIII and InIV. The transitions from $^3D_1$, $^3P_1$ and $^1P_1(4d^95p)$ to $^1S_0(4d^{10})$, the latter being the lowest level in each of these spectra, have also been identified for AgII, CdIII and InIV. These combinations account for nearly all of the strong lines in each spectrum. The term values for the four iso-electronic systems PdI, AgII, CdIII and InIV, together with those for the corresponding elements in the first long period, have been plotted on a Moseley diagram which brings out certain similarities and variations between these two sets of spectra. The validity of the irregular doublet law is again confirmed by the almost constant shift in the corresponding radiated frequencies ($4d^95s - 4d^95p$) on passing in succession from PdI to AgII, to CdIII and to InIV. [See also Abstract 1930 (1928).]

AUTHORS.

RADIOACTIVITY.

2413. New Investigations of the Penetrating Radiation of Hess. E. Steinke. *Zeits. f. Phys.* 48. 9–10. *pp.* 647–689, 1928.

A new apparatus was employed, with an ionisation chamber filled with CO_2 under pressure, and with an iron armour built up in sections, by means of which thicknesses of 4, 8 and 12 cm. of iron can be obtained, with different angles of complete or partial opening. The drift of the electrometer, due to radioactivity in the interior of the instrument, was much smaller than in previous ones, only 0·2J. Intensity, absorption and direction measurements were made near sea-level, and at 1600 and 2500 metres. The author concludes that the penetrating radiation is not homogeneous; the smallest absorption coefficient in lead which has been measured is $\mu = 0{\cdot}0042$ cm.$^{-1}$, this radiation being about 100 times as penetrating as normal radium radiation, wave-length estimated as 0·07 X.U., corresponding to an energy level of 177 million volts, which approaches that which would be theoretically set free if matter were transformed into energy. Scattered energy is also important, and affects the ionisation; scattering takes places in air and in iron, but apparently the amount of it in lead is small. The daily variations in the intensity were studied for four days at 2500 m. elevation, and were found to be considerable though smaller than those measured by other investigators at the same height. Difficulties were found in explaining the effect of barometric height on the intensity. H. N. A.

2414. Preparation of Highly Concentrated Polonium Sources by Distillation. Elisabeth Rona and E. A. W. Schmidt. *Akad. Wiss. Wien., Ber.* 137. *2a. No.* 1–2. *pp.* 103–115, 1928. *Zeits. f. Phys.* 48. 11–12. *pp.* 784–789, 1928.

Experimental details are given of a modification of the method used by Bonet-Maury for the vaporisation of polonium [see Abstract 2939 (1927)]. The polonium to be distilled is deposited electrolytically in small concentration (up to 1000 e.s.u./cm.^{2}) from $N/10$ HNO_3 radium D solution on large platinum electrodes of about 0·02 mm. thickness, using a current density of $5 \cdot 10^{-6}$ amp./cm.^{2}. The distillation is carried out in a slow stream of hydrogen in a quartz tube about 15 cm. long and 1 cm. in diameter, constricted in the middle to about 3 mm. diameter. The strip of platinum electrode, in the narrow part of the tube, is heated by means of a micro-oxyhydrogen blowpipe, the receiver, a small plate of palladium or platinum, being about 3 mm. distant. By this method, yields of 60–80 % of the vaporised polonium are obtained on the first distillation, decreasing to 40–50 % on further distillation. L. L. B.

2415. Ultra-Violet Spectrum of Radium Emanation. S. Wolf. *Zeits. f. Phys.* 48. 11–12. *pp.* 790–794, 1928.

The spectrum of radon, hitherto only extensively investigated in the visible region, has been studied by means of a quartz prism apparatus, and about a hundred new lines between 3600 and 2400 Å. have been measured. By the use of a tube of uviol glass, blown out at one end to an extremely thin-walled bulb, the investigation may be extended farther into the ultra-violet. A table of wave-lengths is given, ranging from 2760·8 to 2377·9 Å. L. L. B.

2416. Purification of Radon. L. Wertenstein. *Phil. Mag.* 5. *pp.* 1017–1027, *May,* 1928.

A description is given of a method of purifying radium emanation obtained from solutions of radium compounds, and in the presence of organic contamination due to the substances (tap-grease, etc.) used in the transfer pumps. The usual impurities extracted from solution by these pumps are: hydrogen, oxygen, CO_2, mercury and water-vapour. The presence of hydrocarbons is probable on account of the decomposing influence of α- and β-particles on organic substances in the apparatus. The experiments described are similar in principle to those of Rutherford, with the difference that CuO was used instead of sparking and that communications in the purification apparatus were obtained by means of mercury forks in order to avoid the evolution of CO_2 from the tap-grease. In Rutherford's work the latter difficulty was overcome by using P_2O_5 for tap-grease. CO_2 is the chief stumbling-block in obtaining a good purification of radon. The work described was undertaken in the course of a determination of the volume of 1 Curie of radon. A. B. W.

2417. Regularities of Radioactive Change. H. T. Wolff. *Zeits. f. Phys.* 48. 9–10. *pp.* 745–746, 1928.

A note on W. A. Sokolow's paper [see Abstract 374 (1928)], whose relation between the disintegration constant of an α-radiator and its number in the disintegration series is shown to follow from one of the equations previously obtained by the author [see Abstracts 1608 (1920), 1571 (1921) and 339 (1922)], taken in conjunction with the Geiger-Nuttall formula. H. H. Ho.

2418. Action of the Geiger α-Particle Counter. J. Taylor. *Cambridge Phil. Soc., Proc.* 24. *pp.* 251–258, *April,* 1928.

A brief statement of the problem, with a discussion of the action of the counter from the standpoint of the " threshold current " hypothesis and the form of the current-voltage characteristic, and the author's photoelectric theory of sparking potentials. Special notice is given to the " self-restoring " action of the counter. H. R. R.

2419. Some Experiments on Geiger Ion Counters. R. D. Bennett. *J.O.S.A. and R.S.I.* 16. *pp.* 339–354, *May,* 1928.

With the purpose of extending the usefulness and reliability of the Geiger ion counter an investigation of its behaviour under widely varying conditions was undertaken, including the effect of the size of the point and the chamber, the position of the point in the chamber, the effect of voltage on the sensitivity, the effect of the nature and pressure of the gas used, the sensitivity to ultra-violet light, the sensitivity to ions of small energy, the effect of various properties of the electrical circuits, and an investigation of the time lag in its action. It is concluded that the counter is a very sensitive instrument for detecting single ions; that it is only a moderately sensitive detector of ultra-violet light because of low efficiency; that it is primarily a qualitative instrument, though of possible quantitative use subject to the difficulty of keeping the sensitivity constant over the long periods necessary to take statistical averages. Some surmises are made as to the manner of its action. AUTHOR.

2420. Ranges of the α-Particles of Uranium I and II. G. C. Laurence. *Phil. Mag.* 5. *pp.* 1027–1038, *May,* 1928.

The ranges of the α-particles of uranium I and II were determined by the Wilson cloud chamber method, with modifications made necessary by the small activity of the radioactive material. The method was satisfactorily checked by its application to the range of polonium. The ranges at 150° C. and 760 mm. of mercury were found to be: Uranium I, 2·73 cm.; uranium II, 3·28 cm., with a probable error of less than 1 %. From the range of uranium II its decay constant was calculated to be $1 \cdot 7 \times 10^{-12}$ sec.$^{-1}$, or a half-life of 13,000 years. A. B. W.

2421. Products of Atomic Disintegration, Reflected α-Particles and X-Rays Excited by α-Particles. W. Bothe and H. Fränz. *Zeits. f. Phys.* 49. 1–2. *pp.* 1–26, 1928. *From the Reichsanstalt.*

Polonium was used as the source of the α-rays and a Geiger point counter to count the number of the particles produced by atomic disintegration; reflected α-particles and the characteristic X-rays of the substances bombarded also produced deflections; but it was possible to eliminate the two latter classes of deflection by properly choosing the gas contents of the counter, and using absorption foils with suitable atomic numbers; the remaining deflections, due to the disintegration products, are so small in number for Be, C, Al and Fe that the observations cannot be brought into harmony with the results of the Vienna investigators, and they indicate the correctness of the Cambridge results. With carbon there were signs that the reflection of α-particles at 127° is stronger than is to be expected from Rutherford's theory. The results of former experiments were confirmed with a stronger radiation source. It was shown that with boron two groups of disintegration rays occur, with different ranges, which may originate in the two isotopes. In considering the reason for the discrepancy with the Vienna results, it is suggested that scintillations may be produced by β-rays in a zinc sulphide screen under certain circumstances. H. N. A.

2422. Relation between Mean Stopping Power and Mean Range of β-Rays. E. J. Williams. *Cambridge Phil. Soc., Proc.* 24. *pp.* 315–319, *April*, 1928.

A mathematical paper dealing with the determination of range and stopping power when β-rays traverse a Wilson cloud chamber. A. B. W.

2423. Photographic Action of H-Rays from Paraffin and Atomic Fragments. Marietta Blau. *Zeits. f. Phys.* 48. 11–12. *pp.* 751–764, 1928.

By means of the method previously described [see Abstract 155 (1927)], a detailed investigation has been made of the photographic action of natural H-particles, using a paraffin film 10–30 μ thick and a polonium preparation as the source of α-particles. A comparison of the tracks of the H-rays on the photographic plate with those of α-rays obtained under similar conditions showed that in every case the distance between the points on the H-particle tracks was greater than that on the α-particle ones, particularly for fast H-particles, for which the distance was nearly doubled. The theoretical significance of this is discussed, with special reference to the influence of the range of the H-particle. By means of the " retrograde method " used by Pettersson [see Abstract 2310 (1927)], the effect of the bombardment by α-particles of Acheson graphite, diamond, amorphous carbon, aluminium, beryllium, and gold has also been investigated. The photographic method is found to be unsuited for use with gold and diamond, but in the case of all the other substances, H-particle tracks were observed. The disadvantages of the photographic method for the quantitative investigation of atomic disintegration are discussed. L. L. B.

2424. Scintillation Method. Berta Karlik and Elisabeth Kara-Michailova. *Zeits. f. Phys.* 48. 11–12. *pp.* 765–783, 1928.

Experimental details for the scintillation method of counting α- and H-particles are discussed. The factors on which the size and brightness of the scintillations depend are reviewed, with special reference to the mass and velocity of the bombarding particle and to the nature and particle-size of the screen material. Experiment shows that in the case of α-rays there is a close relation between the brightness of the scintillation and the energy given up from the α-particle in the crystal. A working hypothesis is suggested to explain the mechanism of the scintillation process, based on the assumption that zinc sulphide possesses centres which are already in an active condition. Measurements of the total luminescence of a zinc sulphide screen bombarded with α-rays show that this is proportional to the number of α-particles; the observations in general confirm those made with single particles. The preparation and gauging of scintillation screens are discussed in the light of the experimental results. L. L. B.

HEAT.

2425. Apparatus for the Determination of Coefficients of Expansion. J. W. W. Willstrop. *Journ. Sci. Instruments,* 5. *pp.* 130–132, *April,* 1928.

Describes a simple form of apparatus for measuring the coefficient of expansion of bars about 1 ft. in length. It consists essentially of two bars, both of the metal in question, or, preferably, the one of the metal and the other of another metal of known coefficient, suspended parallel to each other and in the same horizontal plane, as close together as circumstances will permit. Each bar is immersed in a separate bath, and while one end of each bar is fixed the other is pivoted on a stirrup carrying a vertical plane mirror and free to rotate about a vertical axis. An illuminated scale is viewed through the mirror by means of a telescope with cross wires, and from the shift observed when the temperature of the bath containing the bar of unknown coefficient is raised the actual expansion, and hence the coefficient, can be calculated. E. G.

2426. Simplified Formulæ for Specific Heats of Gases and Solids, especially of Explosion Products. N. Yamaga. *Imp. Acad. Tokyo, Proc.* 4. *pp.* 102–105, *March,* 1928. *In English.*

Following the work of Eucken on the specific heat of gases, the author has deduced formulæ for the specific heats of explosion products generated at high temperatures between 3000°–4000° absolute. For gases, such as H_2, CO_2, H_2O, NH_3, diatomic gas, Cl_2, etc., his formulæ are expressed in the form $C_v = n\mathrm{R} + m\phi(\theta/\mathrm{T})$, the value of the constants n, m and θ being given for each gas. In order to calculate the specific heats of solid bodies produced during the explosion, use is made of the formula of Nernst-Lindemann. References are given in the paper to literature relating to the subject. W. C. S. P.

2427. Accurate Determination of Specific Heats of Salt Solutions up to 80° C., including Results for Potassium Nitrate and Chloride Solutions. F. T. Gucker, Jr. *Am. Chem. Soc., J.* 50. *pp.* 1005–1016, *April,* 1928.

A twin adiabatic calorimeter capable of working at temperatures up to 80° C. was developed. The heat was supplied by electric heaters, and the temperatures were measured by thermoelements. The apparatus was standardised by means of water, and a simplified method was evolved. With this modified standardisation it was unnecessary to determine the sensitivity of the thermoelement-galvanometer system or the heat capacity of the calorimeters. The volume of the calorimeters was reduced from 600 c.c. to 250 c.c., and the temperature range from 4° to 2°, but other refinements more than compensate for these reductions. The accuracy was at least 0·5 per mille, even at the highest temperatures. The specific heats of potassium chloride and nitrate were studied at 20°, 50° and 80°. No great change was observed over this range, but they do not confirm F. Zwicky's theory of the specific heat of such solutions. F. J. B.

2428. Specific Heats C_p and C_v of Certain Substances in the Solid, Liquid and Supercritical States between 80° and 320°

Absolute. A. Eucken and F. Hauck. *Zeits. f. phys. Chem.* 134. 3–4. *pp.* 161–177, *June*, 1928.

The object of the paper is to increase our knowledge of the value of C_v in the neighbourhood of the critical point and to extend the data for the value of C_p for certain fluids employed in the refrigerating industry. The apparatus employed is a modification of that used by Eucken [see Abstract 514 (1917)]. The purification of the gases used is fully described and the accuracy of the measurements is discussed. The equation for a two-phase system, *i.e.*, $C_{1\cdot 2} = m_1 C_{s1} + m_2 C_{s2} + \frac{dm_1}{dT} l$ was used in the calculations, where C_s denotes specific heat in the saturated state and l the latent heat of vaporisation; the indices 1 and 2 refer to the vapour and liquid respectively. The results obtained are plotted in 10 diagrams, the substances dealt with being carbon dioxide, nitrous oxide, ethylene, methyl-chloride, ethane and air. The values of C_v for air are found to agree very well with those obtained by Hausen from the Joule-Thomson effect except at the lower temperatures. In the case of air and argon a considerable decrease in the value of C_v with increasing temperature was found, this decrease commencing below the critical point, the theoretical value $\frac{3}{2}$R being nearly reached. T. B.

2429. Theory of the Specific Heat C_v of Monatomic Liquids at High Temperatures. A. Eucken and H. Seekamp. *Zeits. f. phys. Chem.* 134. 3–4. *pp.* 178–189, *June*, 1928.

An attempt is made by the authors to explain the decrease in the value of C_v with increasing temperature found by Eucken and Hauck for argon [see preceding Abstract]. This decrease is also very remarkable in the case of mercury, as the following figures show.

Temp. C°	− 37°	0°	100°	200°
C_v............	6·45	5·97	5·45	5·30

It is well known that the molar heat C_v for monatomic liquids has approximately the value 6 cal. (neglecting hydrogen and helium). This consists of equal amounts of kinetic and potential energy. It is very probable that a part of this potential energy is due to association which shows itself in large molar heat in the neighbourhood of the melting point and rapidly diminishes as the temperature rises. But as the value does not approach the kinetic gas value $\frac{3}{2}$R, we become convinced that the potential energy must in part consist of energy other than that due to association. This part of the potential energy is probably due to a vibration of the atoms of the liquid. To explain the existence of this vibrational energy the authors assume a replusive law of force between atoms of the form $F = a/(r^n + 1)$, where r denotes the variable distance between the atoms due to vibration. The calculation is carried out as far as graphical integration allows and the results agree qualitatively but not quantitatively with the experimental results. T. B.

2430. Specific Heats C_1^1 and C_2^1 of Liquid and Saturated Vapour along the Boundary Curve at the Critical Temperature and at T = 0, and Latent Heat of Evaporation at T = 0. J. J. van Laar. *Zeits. f. phys. Chem.* 134. 3–4. *pp.* 311–328, *June*, 1928.

From the p.v. diagram it follows that at Tk_1 C_1^1 for the liquid approaches the value $+\infty$ and C_2^1 for the vapour the value $-\infty$. Further, at

$T = 0$, $C_2^1 = -\infty$, and at intermediate temperatures C_2^1 is positive; hence there are two points at which a change of sign takes place. For the liquid C_1^1 is always $+ ve$. The values of the thermal and calorimetric values at Tk had been obtained by the author in 1893 [*Zeits. f. phys. Chem.* 11. *pp.* 721–736, 1893]. Raveau and Bakker had also obtained results in 1893. Bennewitz and Splittgerber [see Abstract 718 (1927)] conclude that at Tk_1 C_1^1 and C_2^1 are both finite. Schidlof, Perrakis, and especially v. Kolosowsky, have obtained strange results. The object of the paper is to show the fallacies in the work of these later authors, especially as they have repeated the publication of their incorrect deductions. With this object in view the author develops the fundamental equations and calculates the values of the thermal quantities involved, and shows that the errors of the authors mentioned are due to a wrong interpretation and use of the partial differential equations of the thermodynamics employed. T. B.

2431. Micro-Calorimeter. S. G. Lipsett, F. M. G. Johnson and O. Maass. *Am. Chem. Soc., J.* 50. *pp.* 1030–1033, *April,* 1928.

A small calorimeter was designed for use in determining the heats of solution. The calorimeter was made of platinum and required only 4 c.c. of solvent and a correspondingly small amount of the solute. The heat capacity of the calorimeter was approximately 1 cal. Determinations of the heat of solution of sodium chloride at the same concentration gave results which did not differ from a mean value by more than 0·26 %. F. J. B.

2432. New Adiabatic Calorimeter for High Temperatures. W. Kangro. *Zeits. f. Elektrochem.* 34. *pp.* 253–256, *May,* 1928.

This instrument enables thermal measurements to be made at about 800° C.–900° C. and is an arrangement of concentric electric furnaces which admit of automatic regulation so that the inner calorimeter is under very exact adiabatic control. H. H. Ho.

2433. Occurrence of Sulphur-Dust Explosion through Spark-Ignition. P. Beyersdorfer and L. Braun. *Zeits. f. tech. Phys.* 9. 1. *pp.* 14–17, 1928.

The paper describes some experiments suggested by the frequent occurrence of sulphur-dust explosions in a sulphur grinding-mill, to ascertain the ignition temperature of sulphur and the possibility of spark ignition. The ignition temperature was found to be about 215° C., whereas for sugar dust it is approximately 410° C. It was found that sparks produced by rubbing a piece of steel or iron on a carborundum disc easily fired sulphur dust, but not sugar dust. The rest of the paper gives calculations of the heat necessary to fire a sulphur particle and the heat yielded by an iron spark, and the same are calculated in the case of sugar. The limits of concentration of sugar and sulphur dust are calculated between which spark ignition is possible. It is found that they are much wider for sulphur than for sugar. T. B.

2434. Conception of Inflammability. P. Beyersdorfer and L. Braun. *Zeits. f. tech. Phys.* 9. 1. *pp.* 17–19, 1928.

There appears to be no quantitative definition of inflammability. The object of the paper is to supply one and to give examples of its value. Inflammability is defined as the ratio $\frac{\text{heat of combustion}}{\text{heat of ignition}}$, the heat of combustion being the number of calories set free in the complete combustion of 1 gm. of the substance. The heat of ignition is taken to be the number of calories which must be given to 1 gm. of the substance in order to raise its temperature from 0° C. to the temperature of ignition. It is pointed out that neither of these quantities alone is sufficient to define inflammability. The following values are thus obtained for the substances mentioned:—

H_2.	CS_2.	Phosphorus.		Sulphur Dust.	Aluminium Powder.
		Yellow.	Red.		
25	62	834	128	39	60

T. B.

2435. Irregular Mode of Spherical Propagation of Flame. T. Terada and K. Yumoto. *Imp. Acad. Tokyo, Proc.* 4. *pp.* 98–101, *March*, 1928. *In English.*

In a previous communication the authors have shown that when some combustible mixture of H_2 and air is ignited by a small spark, the flame front, which is nearly spherical in its initial stage, is corrugated by a characteristic pattern of irregular creases. They now show that the corrugation is not merely determined by the magnitude of the velocity of propagation. Mixtures of CO, C_2H_2, or coal-gas and air, which are of the same order of velocity of propagation as the H_2-air mixtures showing marked corrugations, give a very smooth spherical flame front. Some experiments carried out with the electrodes partially covered with glass tubing suggest that the corrugation in some cases is brought about by the shrinkage of the volume of the gas on the inside of the flame front by the rapid condensation of the water vapour formed. The addition of some anti-knock substance, such as C_2H_5Br or C_2H_5I, to a low percentage mixture of hydrogen with air has the effect of reducing the characteristic corrugation. W. C. S. P.

2436. Gaseous State of Normal Substances. K. Wohl. *Zeits. f. phys. Chem.* 133. 5–6. *pp.* 305–349, *April*, 1928.

The validity of Wohl's principal equation for normal substances [*Zeits. f. phys. Chem.* 87. p. 1, 1914; 99. pp. 207, 226, 1921] extends below the critical temperature to the quite stable gaseous state, at the critical temperature to the critical volume, and increases with rising temperature until from $T = 2 \cdot 53T_k$ the volume has the limiting value $\frac{v_k}{4}$. The theorem of corresponding states is, for the gaseous state of normal substances, more accurately applicable than has been formerly recognised, and for normal substances the equation mentioned forms a valuable aid to the elimination of errors of measurement. Values previously published for the volumes of saturated sulphur dioxide at low temperatures and forming the basis of the technical tables of the thermal properties of sulphur dioxide, indicate that sulphur dioxide is associated in the gaseous state, but the principal equation shows that this gas is a normal substance. The second virial coefficients of normal substances agree well in the reduced mass system. In the region of temperature from $0 \cdot 8T_k$ to $2 \cdot 5T_k$, these coefficients are given accurately (within the limits of error) by the principal equation, whereas Berthelot's equation gives a rather high value. Below $0{\cdot}8T_k$ the absolute values of the second (negative) virial coefficients increase with falling temperature rather more rapidly than the equation requires, so that the attraction potential of the molecule is here dependent on temperature to a greater extent than mere inverse proportionality would indicate. The class of normal substances extends from symmetrical quadripole molecules to those with a high dipole moment. For an associated substance the high dipole moment is not, as such, characteristic, but extreme preponderance of the orientation polarisation effected by the dipole moment over the polarisation due to displaceability of the electrons and atoms. Keesom's theory, according to which the attraction of the molecules is effected essentially through their orientation by means of their stable electric moments, and also that of Falkenhagen on the attraction of dipole gases, are not reconcilable with the experimental behaviour of normal substances. T. H. P.

2437. Compressibility Isotherms of Hydrogen, Nitrogen, and a 3 : 1 Mixture of these Gases at Temperatures between 0° and 400° and at Pressures to 1000 Atmospheres. E. P. Bartlett, H. L. Cupples and T. H. Tremearne. *Am. Chem. Soc., J.* 50. *pp.* 1275–1288, *May*, 1928.

Continuing previous work on the physical properties of hydrogen and nitrogen and their mixtures at high pressures, the compressibility phenomena of hydrogen and nitrogen was determined over a range of temperature from 0° to 400°, and through a pressure range of 1000 atmospheres. At the lower temperatures there is a decided deviation from the additive volume rule, but at 300° the rule was found to hold within the limits of experimental error. The additive pressure rule was discussed and was shown to hold to within 2 % if defined in the following terms: "The pressure exerted by one constituent in a gaseous mixture equals the product of its mole fraction and the pressure it would exert as a pure gas at a molecular concentration equal to the molecular concentration of the mixture." F. J. B.

2438. Heat of Formation of Molecular Hydrogen. F. R. Bichowsky and L. C. Copeland. *Am. Chem. Soc., J.* 50. *pp.* 1315–1322, *May*, 1928.

In a previous communication by one of the authors [see Abstract 1071 (1927)] it has been shown that the formula for the rate of effusion of a pure gas through a small hole can be employed to determine the percentage of thermal dissociation. This result is now made use of in the present work. Hydrogen is admitted to a discharge tube at a known rate of flow. The partially dissociated gas then passes through a number of very small holes at the end of a side tube attached to the discharge tube. The gas is then catalytically associated in a platinum calorimeter the temperature-rise of which gives the energy of association. The percentage of atomic hydrogen causing the change is determined by the difference in the pressure of the gas before passing through the small holes under steady state conditions of no dissociation (*i.e.*, no discharge) and the pressure of the steady state conditions of dissociation (*i.e.*, with discharge). Two hours of continuous discharge were necessary to give a steady pressure in the discharge tube. The temperature of the calorimeter was recorded every minute by means of a Beckmann thermometer. To check the method a blank experiment was carried out by inserting a piece of platinum gauze in the tube leading from the discharge tube. The gauze was used to associate all the atomic hydrogen before it reached the small hole system. The results of the blank experiment showed that there was no observable pressure difference between the steady state of discharge and the steady state of no discharge, and there was no observable heat effect in the calorimeter. The value the authors obtained for the heat of formation of molecular hydrogen was 105,000 ± 3500 calories.

W. C. S. P.

2439. Method for Observing Minimal Quantities of Helium. F. Paneth and K. Peters. *Zeits. f. phys. Chem.* 134. 5–6. *pp.* 353–373, *June*, 1928.

Describes the apparatus employed for separating helium and neon from mixtures of other gases; all of these except hydrogen can be removed by means of charcoal cooled with liquid air. Three different methods of removing hydrogen were employed in the apparatus: absorption by heated metallic calcium with the formation of calcium hydride for large quantities of H_2; O_2, N_2 and CH_4 are removed at the same time by the heated calcium; for H_2 alone a red-hot palladium tube closed at one end was employed, the H_2 diffuses through the palladium and is pumped away, leaving the helium and neon; to remove the last traces of H_2 a process of catalytic combustion is employed, an excess of O_2 being added to the gas; heated palladium sponge is used as the catalyst. The purified He and Ne are at a very low pressure, and are compressed into a fine capillary tube at the top of a MacLeod vessel, where the light of an electric discharge through them is examined spectroscopically. It is possible in this way to identify an amount of either gas the volume of which at normal temperature and pressure is 10^{-10} cm.³. H. N. A.

2440. Cryoscopic Study of Benzene Solutions. J. M. Peterson and W. H. Rodebush. *J. Phys. Chem.* 32. *pp.* 709–718, *May*, 1928.

It is pointed out, as, for example, with reference to acetic acid, that water is known as a "dissociating" solvent and benzene as an "associating" solvent, but it is questioned whether benzene is other than an inert solvent. This and kindred questions, it is suggested, can be answered by obtaining complete data for the partial pressures of solvent and solute, but as dilute solutions can only be used where any of the solution laws are employed, it is necessary to adopt the indirect cryoscopic method, equivalent to measuring the vapour pressure of the solvent only. An exact thermodynamical equation is derived relating the freezing point depression of a dilute solution to the vapour density of the solute. Data are given for the lowerings of the freezing point of dilute benzene solutions of a number of solutes and the vapour densities of the solutes are calculated from these data. J. K.

2441. Determination of Molecular Weight of Saturated Vapours of Pure Liquids and their Mixtures by the Dynamic Method. M. S. Wrewsky. *Zeits. f. phys. Chem.* 133. 5–6. *pp.* 357–361, *April*, 1928.

The paper includes a review of methods in this field and then investigates the isothermal dynamic method, using the equation $V(B + b)/(B + b - P) = V + m_1 RT/(B + b) + m_2 RT/(B + b)$, where V is the volume of air introduced, B the atmospheric pressure, *b* the hydrostatic pressure of the liquid, P the vapour pressure of the two liquids used for the mixture, m_1 and m_2 the number of moles passing over in the vapour, T the absolute temperature and R the gas constant. H. H. Ho.

2442. Dissociation of the Vapours of Acetic Acid and Equilibrium between its Aqueous Solutions and their Vapours. M. S. Wrewsky, K. P. Miščenko and B. A. Muromzew. *Zeits. f. phys. Chem.* 133. 5–6. *pp.* 362–369, *April,* 1928.

Previous work is first reviewed and tables are included showing deviations between the values found by Ramsay and Young for the densities of the unsaturated and saturated vapours of acetic acid and those calculated from the Gibbs formulæ. The authors' method enables the density of saturated vapours to be determined immediately, adsorption influences being excluded, and tables of data are now given for vapour density changes of acetic acid for concentration changes of aqueous solutions at constant temperature. H. H. Ho.

2443. Dissociation of the Vapours of Formic Acid and Equilibrium between its Aqueous Solutions and their Vapours. M. S. Wrewsky and A. A. Glagoleva. *Zeits. f. phys. Chem.* 133. 5–6. *pp.* 370–376, *April,* 1928.

Gives a parallel investigation for formic acid to that by Wrewsky, Miščenko and Muromzew. [See preceding Abstract.] H. H. Ho.

2444. Equilibrium between Vapour and Liquid for Solutions of Formic Acid and Benzene. M. S. Wrewsky, N. A. Held and S. A. Ščukarev. *Zeits. f. phys. Chem.* 133. 5–6. *pp.* 377–389, *April,* 1928.

From the experimental curves obtained it is established that in the presence of benzene the vapours of formic acid are associated to a much greater extent than from aqueous solutions at the same temperature and solution composition. It is concluded that the differences found between the two systems are connected with the associating effect of benzene in the liquid medium. The cryoscopic determinations have shown that formic acid in water possesses a normal molecular weight, whereas it is double in benzene solution. An almost doubled molecular weight has been found in the vapours of formic acid from benzene mixtures. H. H. Ho.

2445. Vapour Pressure Measurements for Ag, Au, Cu, Pb, Ga, Sn and Calculation of the Chemical Constants. P. Harteck. *Zeits. f. phys. Chem.* 134. *pp.* 1–20, *May,* 1928.

The author describes an apparatus by which vapour pressures of the high-boiling metals Ag, Au, Cu, Ga, Sn are measured by the Knudsen method at about 1000° C. and 10^{-4} to 10^{-2} mm. The vapour pressure of lead was determined by an ebullition method, and previous data are discussed. The chemical constants of Pb, Ag, Cu, Au and C have been evaluated anew, deviations from the theoretical values discussed, and a positive deviation of about 0·3 shown to be compatible with most results. The Trouton rule is found applicable to boiling metals when the Sackur-Tetrode value of the chemical constant is adopted, account also being taken of the above deviation. The Langmuir method for the measurement of small vapour pressures is discussed and current data shown to contain appreciable errors in many cases. [See also Abstract 3092 (1924).] H. H. Ho.

SOUND.

2446. Recording and Reproduction of Sound. A. Whitaker. *Journ. Sci. Instruments,* 5. *pp.* 35–41, *Feb.,* 1928. *Paper read at Annual Exhibition of the Phys. and Optical Soc., Jan.,* 1928. *Engineering,* 125. *p.* 400, *March* 30, 1928.

A summary of recent advance based upon analogies between mechanical and electrical systems. It has always been known that gramophone records become scratchy and harsh after a considerable number of playings. Microscopic examination shows this to be due to disintegration of the record material, and also brings to light remarkable aspects of record wear. In most cases some notes are selectively worn, and the wear shows itself in a series of patches, distributed regularly along the groove, whose phase relation to the record wave varies from one case to another. This is due to the fact that the load is not purely resistive but contains reactive components which vary with the frequency and are out of phase with the velocity. A well-designed gramophone system puts a heavy load on the record and gets a high acoustic output, but the reactive component is small and the wear is actually less than that due to the old-type gramophone with very much smaller volume. A pick-up takes far less useful work off a record than a sound-box, of the order of one-hundredth usually, and so the wear due to a pick-up should be relatively small. Actually it has been found that the wear due to nearly all pick-ups is excessive and that it is surprisingly difficult to design a pick-up to give low wear. The trouble lies in the effective absence of a load on a pick-up. The needle is mainly constrained by a series of masses and stiffnesses, which introduce purely reactive and damaging forces on the record. Damping is added, but it is very difficult to obtain non-reactive mechanical damping, and in practice it never approaches the resistance value of the useful load in the case of an ordinary gramophone. It has been found possible to construct a non-reactive pick-up by careful design, and comparative tests show that whereas ordinary pick-ups wear a record 30 % more on an average than an ordinary sound-box, the wear due to a non-reactive pick-up is almost negligible. E. E. F. d'A.

2447. High-Frequency Sound Waves of Small Intensity and their Biological Effects. E. N. Harvey and A. L. Loomis. *Nature,* 121. *pp.* 622–624, *April* 21, 1928.

Some effects of intense high-frequency waves have been described [see Abstract 3165 (1927)]. For the purpose of observing biological material under a microscope an oscillator of relatively low power can be used, if tuned accurately to resonance with the quartz crystal. The method is given with a diagram of the circuit, and some of the effects observed were: progressive destruction of blood corpuscles, rapid rotation of oil droplets in an emulsion and rotation of protoplasm in Elodea cells. G. E. A.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

2448. Operational Calculus. L. Straneo. *Accad. Lincei, Atti*, 6. *pp.* 292–295, *Nov.* 6, 1927.

The expansion of certain operational functions appears to lead to invalid results which cast doubt on Heaviside's procedure. This paper, which is purely mathematical, investigates the conditions of validity and enunciates a theorem which defines the conclusions to be drawn from the apparent inconsistency. A. Wh.

2449. Electron Theory of Metals on the Basis of the Fermi Statistics. E. Kretschmann. *Zeits. f. Phys.* 48. 9–10. *pp.* 739–744, 1928.

A note on a recent paper by Sommerfeld [see Abstract 1368 (1928)], in which the most difficult point in the whole theory is stated by that author to be that the mean free path of the electrons has to be regarded to a first approximation as independent of the temperature. The author shows that this assumption is not necessary in order to deduce Sommerfeld's formulæ for σ and κ; the paper is mathematical throughout. H. N. A.

2450. Trouton and Noble Experiment. R. Ferrier. *R.G.E.* 23. *pp.* 397–399, *March* 3, 1928.

The author refers to the influence of Maxwell's equations on the evolution of science, and outlines subsequent developments in continuous geometry and conceptions regarding the structure of matter and electricity. In his view, the correct interpretation of Maxwell's equations in the molecular system should be sought by retaining the classic definitions of space and time. Referring to the Trouton and Noble experiment, the author maintains that the torque calculated by Maxwell's equations is indeterminate, and there is nothing to prevent its being zero. The Maxwell equations give a correct result whenever the latter is independent of the molecular hypothesis; otherwise the solution is parasitical and does not correspond to reality. The indetermination revealed by the author in regard to the Trouton and Noble experiment exists in all the "crucial" experiments designed to investigate the absolute movement of an electrical system through the ether. If Maxwell's equations are to be applied correctly, it is necessary to ascertain whether or not the result obtained depends upon the manner in which the limit is reached. Neglect to observe this purely mathematical precaution may falsify a complete system of scientific philosophy. R. E. N.

2451. Problem of a Hidden Polarised Sphere. A. Petrowsky. Parts II and III. *Phil. Mag.* 5. *pp.* 914–933, *May*, 1928. *Supplement.*

This paper is a continuation of Part I on the same subject [see Abstract 1670 (1928)]. In Part I a general solution of differential equations was found, expressing a distribution of electric force, and general characteristics of electroprofiles were given obtained by observations on the plane of division. In Part II the following question is examined: It is supposed that the observer, wishing to determine the exact place of the hidden sphere, has chosen a certain arbitrary direction, has drawn in that direction a row of parallel equidistant lines, and has taken electroprofiles along each of them. He will obtain curves, each of them having two (or one) zero points and three (or two) maxima. Marking on the plan of the section under investigation the places of the zero points and maxima and joining all the corresponding points with smooth curves, he will get five (sometimes three) geometrical loci. The particularities of these loci are considered. The subject is treated by analysis and also by graphical methods, and diagrams are given of (1) curves presenting geometrical loci of zero points (O-curves) of electroprofiles taken parallel to the plane of polarisation (longitudinal electroprofiles); (2) a group of O-curves corresponding to $\alpha = 15°$, $45°$ and $90°$; (3) curves representing geometrical loci of maxima (M-curves) of electroprofiles taken parallel to the plane of polarisation (transversal electroprofiles); (4) a group of M-curves corresponding to $\alpha = 0°$, $15°$, $45°$, and $90°$; (5) geometrical loci of zero points and maxima of transversal electroprofiles; (6) geometrical loci of zero points and maxima of oblique electroprofiles. In Part III a method of definition of elements characterising the hidden sphere by observations of electroprofiles on the surface of division is given. This method is founded on the results of the first two parts of the paper, and special cases are considered. This third part includes (1) an analytical calculation of elements by data obtained by studying the longitudinal electroprofiles; (2) a graphical calculation of position, depth and radius of the sphere; (3) a calculation of elements obtained by studying transversal electroprofiles; and (4) a general case of calculation. Amongst the graphical solutions given is the determination of the direction of the plane of polarisation of the sphere. J. J. S.

2452. Photographs of Lightning Discharges made at the Huancayo Magnetic Observatory. W. C. Parkinson. *Terr. Mag.* 33. *pp.* 23–25, *March*, 1928.

The photography of lightning discharges affords valuable data for the solution of some fundamental problems in atmospheric electricity. In this note a description is given of the methods used to obtain photographs on motion-picture film of lightning flashes at Huancayo, a location very suitable for this work. Specimen photographs are given and briefly discussed, and the necessity for further work is indicated. AUTHOR.

2453. Curious Photograph of Lightning obtained in the Neighbourhood of the Four-Cantons Lake. E. Mathias. *Comptes Rendus*, 186. *pp.* 1334–1336, *May* 14, 1928.

Details are given of a photograph of lightning which showed five luminous points—two bright, one fainter and smaller, and two of medium intensity. The author supposes a lightning discharge descended into a region which was little ionised or not at all and divided into five branches. With the cooling, the fulminating matter contracts under surface tension and forms globules. The branches are of different size and potential and cool at different rates. With the explosion of one globule waves are produced in each of the other four, and these different phases are recorded in the photograph. [See Abstracts 1670, 2000, and 2001 (1927).] R. S. R.

2454. Observations of Atmospheric-Electric Potential Gradient on Mountain Peaks in the Peruvian Andes near Huancayo, Peru. W. C. Parkinson. *Terr. Mag.* 33. *pp.* 15–22, *March*, 1928.

In order to supplement the scanty data on atmospheric potential

gradient on mountain peaks, continuous records were obtained at two stations near the Huancayo Magnetic Observatory of the Department of Terrestrial Magnetism. The first station (Matahuata) was 500 ft. and the second (Cerro-de-Ahuac) was 2200 ft. above the observatory. Curves showing the diurnal variation during fine weather at the two stations and also at the observatory base-station are given and briefly discussed.
AUTHOR.

DISCHARGE AND OSCILLATIONS.

2455. Electric Discharge Figures on Dielectric Plates at Low Air Pressures. T. Itoh. *Imp. Acad., Tokyo, Proc.* 4. *pp.* 16–19, *Jan.*, 1928. *In English. Hokkaids Imp. Univ. Mem.* 1. *pp.* 237–297, *June*, 1928.

A needle point touches the centre of a glass plate in a vacuum, and an alternating current is led to the needle; alternating current and a spark gap are necessary in order to obtain a stable figure. The figure appears when the air pressure is within a definite range, and the range of pressure depends on the size and material of the dielectric plate, the lowest limit being, for all cases, 2 or 3 cm. of mercury. The figures are in the form of radial striæ, and the number of striæ increases linearly with the diameter of the plate, and decreases hyperbolically with the square root of its thickness. Two or more kinds of stable figures can be obtained for the same plate by regulating the series spark gap and the air pressure; in these cases the numbers of striæ are in a simple ratio to one another. Photographs are given. [See also Abstract 1000 (1928).] G. E. A.

2456. Luminous Beads of Metal Particles Sputtered by Disruptive Discharge in a Magnetic Field. H. Nagaoka and T. Futagami. *Imp. Acad., Tokyo, Proc.* 4. *pp.* 106–108, *March*, 1928. *In English.*

In the experiments carried out by the authors on the sputtering of metals by disruptive discharge, using a heavy current between point electrodes, the sputtering is greatly increased when the discharge takes place in a strong magnetic field [see Abstract 1345 (1928)]. The particles are mostly spherical but occasionally ellipsoidal or pear shaped. Most of the particles are solid in the interior but some spheres of brown cerium oxide are only shells. Elements which are oxidisable give out particles with the oxides formed on the surface. Beads are found on the photograms of the tracks of the different elements, which, in the case of Ce and W, are at nearly equal intervals; in the case of Mg the interval between the beads gradually decreases. The authors suggest possible explanations of the formation of the beads: (1) that the light-emitting particle is rotating and that only one side is luminous; (2) by attachment of electrons to the hot particles; (3) through the formation of a film of oxide. Owing to the absence of beads in particles of noble metals the last explanation seems the most probable one. W. C. S. P.

2457. Mechanism of the Arc Light. R. Seeliger. *E.T.Z.* 49. *pp.* 853–857, *June* 7, 1928.

Discusses briefly results previously obtained by the author and other workers [see Abstracts 1421 (1926); 157 and 1682 (1928)]. The first part of the paper deals with the development of the arc discharge from the glow discharge, and it is shown that this development can be followed in its most important stages by means of the kathode spot, as well as from the normal arc characteristics. Measurements on arcs under low gas pressures can also be used. In the second part, the conditions of the anode are considered, and the phenomena obtained when the glow arc changes to the complete arc are described. Comparisons are drawn between the silent carbon arc and the glow metal arc, and also between the hissing carbon arc and the complete metal arc. Finally, new difficulties which have arisen affecting the thermic arc theory are mathematically considered. R. C. F.

2458. Electric Breakdown in Gases. W. Rogowski. *Arch. f. Elektrot.* 20. *pp.* 99–106, *May* 11, 1928.

Various phenomena in connection with the electric breakdown of gases are shown to be very difficult, if not impossible, to explain by means of Townsend's theory of the spark discharge. The effects are discussed in relation to ionisation by impact and space charges. It appears probable that a satisfactory theory of electric breakdown in gases must take account of space charge effects. A. W.

2459. Form and Structure of Sparks. T. Terada and U. Nakaya. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 131. *pp.* 1–19, *Feb.* 19; *No.* 135. *pp.* 65–82, *Feb.* 28; *and No.* 138. *pp.* 103–129, *March* 28, 1928. *In English.*

A description is given of an exhaustive experimental investigation of the form and structure of sparks between electrodes of different shapes in various gases. The effects of different circuit conditions, *e.g.*, introducing a series spark gap, varying the inductance and capacity, etc., are shown in a series of photographs. A. W.

2460. Shadowgraph Method as Applied to a Study of the Electric Spark. H. A. Zinszer. *Phil. Mag.* 5. *pp.* 1098–1104, *May*, 1928.

Photographic life-histories of various spark discharges have been obtained by the use of an apparatus essentially the same as that employed by Foley and Souder for photographing sound waves. The light from a point-source falls directly upon a photographic dry plate several metres away, an object consisting of an electric discharge being placed half-way between. The light from the point-source is refracted, and a shadow of the refracting object is cast upon the plate. A study of the effect of varying the retarding capacity C showed that for low values of C a shadow giving the spark in its brush stage was obtained, while for high values of C the later stages of the spark appeared. By the use of a temporary micrometer gap, photographs of extremely early sparking conditions were obtained, whilst optimum conditions for the study of sound pulses were found by using a low variable inductance. Plates are reproduced of a brush discharge of a weak spark, the striation stage of the spark discharge, and Trowbridge's " pilot " spark, where metallic vapour is beginning to diffuse into the gap-space. L. L. B.

2461. Presence of Charges at an Electrode Surface. W. Clarkson. *Phil. Mag.* 5. *pp.* 1104–1110, *May*, 1928.

Experiments have been made to determine whether at any time after an electrical discharge a charge or field exists at an electrode surface. With (*a*) a detecting system of a few cm. capacity and a sensitivity of 1/100 volt; (*b*) discharges in air from brush discharges to sparks of several mm. or alternating fields; and (*c*) electrodes, polished or rough, sensitised, clean or impure, it is found that no detectable charge is given up by a steel needle after 1/1000 sec. interval, and that no field can be detected by a point 1/10 mm. distant from a brass knife-edge after an interval of 1/600 sec. Charges amounting to several volts were recovered, however, when the insulator was exposed to the slightest influence of varying fields or of radiations from the discharge. A consideration of related work shows that, if charges actually were involved, they would be much greater than those detectable in the present experiments, and it is concluded that, with respect to electrical charges, the system responsible for polarisation, whether reversible or irreversible, must be a closed one. The assumption that reversible polarisation is due to a charged layer at the kathode surface leads to an explanation of contact potential, sparking potential, and lag variations and the effect of radiations on these. Such a layer represents dynamic equilibrium of the gas and electrode at their interface. L. L. B.

2462. Normal Current Density in the Glow Discharge. A. v. Muralt. *Ann. d. Physik*, 85. 8. *pp.* 1117–1151, *May* 24, 1928.

Experiments were carried out with specially designed apparatus to test the validity of the relation between the extent of the kathode glow and the current given by Hehl [see Abstract 1267 (1905)]. The results obtained with plane electrodes were not in agreement with Hehl's law but satisfied closely the relation $f = c\,i + x\sqrt{i}$, i being the current. With different gas pressures (p) the relations $cp^2 =$ constant and $xp^2 =$ constant were found to hold approximately. With the current in m. amps., the extent of the glow in cm.^{2} and the gas pressure in mm. of mercury, the value of cp^2 in air with aluminium electrodes was found to be 3·0, with gilded electrodes 1·75, and in hydrogen with the latter electrodes 9·1. For very small currents the dark space increased in proportion to $1/\sqrt[4]{i}$. A. W.

2463. Kathode Drop in Glow Discharges. G. Schmerwitz. *Zeits. f. Phys.* 48. 3–4. *pp.* 259–275, 1928.

The dependence of canal rays on the kathode fall measured in the glow discharge from a lime kathode shows a discontinuity at a little over two volts. The supposition that this discontinuity is connected with the Richardson emergence work is confirmed by measurements in a high vacuum. E. E. F. d'A.

2464. Influence of Various Gases upon Wire Vibration in a Corona Discharge Tube. J. E. Snyder and G. M. Evans. *Journ. Sci. Instruments*, 5. *pp.* 166–167, *May*, 1928.

In an all-glass corona discharge tube of the wire-coaxial cylinder type a wire which is still during a 60-cycle discharge in air, ammonia, oxygen, hydrogen or hydrogen-nitrogen mixtures vibrates when these gases are replaced by nitrogen, carbon monoxide or methane. Vibration was prevented by sealing the wire while it was electrically heated and under tension. AUTHORS.

2465. Increase in the Saturation Current from Incandescent Kathodes by Strong Electrical Fields. W. S. Pforte. *Zeits. f. Phys.* 49. 1–2. *pp.* 46–51, 1928.

Describes measurements relating to the influence of strong electrical fields (the potential of the anode) on an incandescent kathode. The saturation current grows with increased field intensity. Schottky's theory, which explains the phenomenon as due to a diminution of the exit work of the electrons by strong fields, is confirmed. If the logarithm of the anode current is plotted against the square root of the anode voltage straight lines are obtained, the slopes of which agree well with those calculated.

H. N. A.

2466. Drop of Potential at the Kathode in Flames. P. E. Boucher. *Phys. Rev.* 31. *pp.* 833–850, *May*, 1928.

The theory as given by J. J. Thomson for the drop of potential at plane electrodes has been modified by allowing for recombination in the layer, and a similar theory for cylindrical electrodes has been worked out. The equation for plane kathodes is

$$V_2 = \left(\frac{32\pi i}{75k_1}\right)^{1/2} x_2^{3/2},$$

and for cylindrical kathodes is

$$V_2 = \left(\frac{2i}{3k_1(r_2^2 - r_0^2)^2}\right)^{1/2} \left[r_2^3 \log\left(\frac{r_2 + (r_2^2 - r_0^2)^{1/2}}{r_0}\right) - r_2^2(r_2^2 - r_0^2)^{1/2} - \frac{(r_2^2 - r_0^2)^{3/2}}{3}\right],$$

where V_2 is the potential drop across the sheath, i the current density, x_2 the sheath thickness at the plane kathode, r_0 the radius of the cylindrical kathode, r_2 the radius of the cylindrical sheath about the kathode, and k_1 the velocity of the positive ions for a gradient of one volt per cm. The experimental results for platinum electrodes immersed in pure and NaCl flames agree well with the theoretical equations given. It is found that the drop in potential at the kathode occurs in a sheath of uniform thickness, which completely surrounds the electrode. By plotting the gas potential at various points in the flame against distance from the kathode it is possible to estimate the thickness of the sheath. Over 95 % of the potential drop takes place across the sheath at the kathode provided it is of clean platinum. If the kathode is not clean electrons are emitted which partially neutralise the accumulation of positive ions and thus reduce the sheath thickness. By measuring V_2, i, x_2 or r_0 and r_2, and making the proper substitutions in the above equations, the mobility k_1 of the positive ions is found to average 12·4 for a pure flame and 8·1 cm. per sec., for one volt per cm. for a NaCl flame. A study of the characteristic current-voltage curve for a wire probe in a flame makes it possible to measure the voltage correction to be applied to the measured probe potential in order to obtain the true gas potential adjacent to the test probe. The correction is of the order of + 1·0 volt. It is found that the current density at the surface of the cylindrical sheath is constant for any given flame conditions and size of kathode. Thus one can measure the current density existing in the small uniform gradient just outside the sheath. The current density at the sheath surface in a pure flame varies from 1·0 to 2·5 microamperes and for the NaCl flame from 5·0 to 11·0 microamperes.

AUTHOR.

2467. Saha Theory and the Conductivity of Flames containing Alkali Metal Vapours. H. A. Wilson. *Roy. Soc., Proc.* 119. *pp.* 1–11, *May* 1, 1928.

In an earlier paper [see Abstract 355 (1923)], the author calculated the equilibrium constants of the reaction M = $M_+ + e$, where M denotes an atom of the alkali metal and e an electron. It was there assumed that

(1) all the alkali metal sprayed into a flame was completely converted into metal vapour, and (2) all the negative carriers in the flames were electrons, and with these assumptions the equation was unaffected. Marx has recently criticised these assumptions, but the author has re-examined the available data and concludes that (1) the fraction f of the metal reduced to the free state and the fraction q of the negative carriers which are electrons are both nearly equal to unity, and (2) the fractions f and q are nearly independent of the concentration of the metal in the flame at 2000° K. Finally, it is shown that the results obtained by different observers on the relative conductivities of the alkali metal vapours in flames at 2000° K. agree approximately with Saha's theory. R. S. R.

2468. Canal Rays and their Charge and Discharge. E. Rüchardt. *Zeits. f. Phys.* 48. 7–8. *pp.* 594–599, 1928.

It is pointed out that the corrections brought forward by Koenigsberger [see Abstract 3174 (1927)] to the measurements of canal-ray discharges furnish no guarantee that the results are now correct. The author of this paper maintains his objections. The supposition of Koenigsberger that the measurements of Wien and the author are falsified by the disturbing influence of neighbouring metal walls is contradicted by observation.

J. J. S.

2469. Reflection of Electrons by Insulators. A. Wehnelt. *Zeits. f. Phys.* 48. 3–4. *pp.* 165–173, 1928.

Publishes two dissertations written in 1922 in connection with his discovery of the reflection of electrons by insulators, which has recently been theoretically deduced by Klemperer. The number of secondary electrons emitted by glass and other insulators increases with the angle of incidence. At potentials of 1300 to 3000 volts a well-marked diminution of the reflected current occurs at a certain angle. This is well accounted for on the wave theory of electrons. E. E. F. d'A.

2470. Focussing Electrons Reflected or Emitted at Equal Angles from a Plane Surface. D. A. Wells. *J.O.S.A. and R.S.I.* 16. *pp.* 355–356, *May,* 1928.

A method is proposed and the theory briefly given for focussing to a line all the electrons of the same energy reflected or emitted at any given angle from a plane surface. It was found that the lines of focus lie on the surface of a cylinder that is tangential to the centre of the reflecting surface and having a radius equal to the radius of the path of the electrons.

AUTHOR.

2471. Reflection of Electrons by a Crystal of Nickel. C. J. Davisson and L. H. Germer. *Nat. Acad. Sci., Proc.* 14. *pp.* 317–322, *April,* 1928.

This paper continues an investigation [see Abstract 712 (1928)] of the interaction between a beam of electrons and a crystal of nickel by directing it against a {111} face at various angles of incidence and measuring the intensity of scattering in the incidence plane as a function of bombarding potential and direction. It is found that whenever the speed of the incident electrons is comprised within any of certain ranges there is an optimum speed at which the intensity of the reflected beam attains a maximum.

H. H. Ho.

2472. Refractive Index of the de Broglie Waves of the Electron. A. Joffé. *Zeits. f. Phys.* 48. 9–10. *pp.* 737–738, 1928.

Remarking on O. Klemperer's paper [see Abstract 1361 (1928)], the author points out that although the existence of potential jumps at the surface of glass, of the order of 1500 volts, is quite possible, the electron reflection phenomena can be explained equally well employing ordinary electromagnetic theory without reference to de Broglie waves. It is proposed, however, to make use of the reflection phenomena to investigate the potential distribution in thin layers of dielectric. W. S. S.

2473. Emission of Particles from Hot Platinum in Air at Atmospheric Pressure. W. D. Flower. *Phil. Mag.* 5. *pp.* 1084–1094, *May*, 1928.

The emission of large ions and nuclei from a hot platinum wire has been studied by means of the ultra-microscopic method developed by Whytlaw-Gray for the examination of aerosols, using bilateral illumination from two 1000-c.p. pointolite lamps. A known current was passed through the wire, then switched off, and it was found that the number of particles subsequently recorded increased to a maximum in about an hour and then diminished. Successive curves for the same temperature progressively decreased in height, indicating that the ability of the wire to emit the particles decreased with use. The general form of the curves is explained by assuming that at emission the particles are too small to be seen, but subsequently coagulate. By means of a photographic apparatus used in conjunction with a continuous action Wilson apparatus, photographs were obtained of the droplets formed on using the particles as nuclei for condensation. The number of particles is now found to be a maximum at zero time and to diminish subsequently along a hyperbolic curve, of which the equation is $dn/dt = -kn^2$, where n is the number present, and k is a constant equal to $0\cdot15 \times 10^{-8}$ cm.^{3}/sec. This is in satisfactory agreement with the value $0\cdot13 \times 10^{-8}$ cm.^{3}/sec. found by Kennedy for the decrease in number with time of large ions and nuclei from a Bunsen flame.
L. L. B.

2474. Effect of Initial Velocity of Electrons upon the Anode Current of a Vacuum Tube. N. Kato. *Phys. Rev.* 31. *pp.* 858–861, *May*, 1928.

Effective initial velocity of electrons emitted from a tungsten filament at different temperatures.—The initial velocity of electrons causes deviation of the anode-current anode-voltage relation of vacuum tubes as derived from the space charge equation. By eliminating the other causes of deviation, the author measured the degree of deviation of the current-voltage curve from the three-halves power law at various filament temperatures, and found that the effective initial velocity of electrons varies from about 0·5 volt at 2250° K. to 4 volts at 3000° K. The effective initial velocity seems to be independent of the dimensions of the electrodes.
AUTHOR.

2475. Cause of Loss of Thermionic Activity of Thoriated Tungsten Filaments. Ann C. Davies and Rhoda N. Moss. *Phil. Mag.* 5. *pp.* 989–1010, *May*, 1928. *Supplement.*

The paper commences with a summary of the work of Langmuir [see Abstract 613 (1924)] and Kingdon and Langmuir [see Abstracts 1436

(1923) and 611 (1924)]. A number of experiments are described with the object of determining the causes of de-activation of thoriated tungsten filaments in a high vacuum, by the application of voltage encouraging emission, at temperatures well below the minimum necessary to cause any decrease of emission due to temperature alone. To this end an investigation was first made of the way in which the emission from an activated filament varied with time during the application of various different arrangements of electric fields, at a series of different filament temperatures and concentration gradients of thorium in the filament. V.S. 8B valves were used; the filament being enclosed in an open spiral grid about 3 mm. diameter, and a cylindrical anode about 1 cm. diameter and 2 cm. length. For details of results the original paper should be consulted. A. B. W.

2476. Photoelectric Effect and Thermionic Emission: A Correction and an Extension. P. W. Bridgman. *Phys. Rev.* 31. *pp.* 862–866, *May*, 1928.

In this note the analysis recently given [see Abstract 1383 (1928)] connecting the photoelectric effect with thermionic emission is freed from the assumption that the photoelectric characteristic frequency is independent of temperature. The thermionic work function and the photoelectric work functions are found to differ by a universal constant, which must be zero in the light of the work of Warner and the recent work of DuBridge. Furthermore, it is found that the temperature derivative at 0° Abs. of the photoelectric threshold differs by a universal constant, which is also probably zero, from $(S_p - S_m)_0$, the difference of entropy at 0° Abs. of surface ions and neutral atoms. The quantity $(S_p - S_m)_0$ enters into the constant of the thermionic emission formula, so that there is a connection between this constant and the temperature derivative of the photoelectric threshold. In spite of the known small value of this latter, experiment allows a sufficient range of numerical values to account for the extreme variation of the thermionic emission constant from the "universal" value. The connection found by DuBridge between the thermionic emission constant and the work function is shown to be reasonable from the point of view of this analysis. AUTHOR.

2477. Photoelectric Threshold and the Heat of Dissociation of the Potassium Molecule. R. W. Ditchburn. *Cambridge Phil. Soc., Proc.* 24. *pp.* 320–327, *April*, 1928.

Absorption curves and photo-ionisation experiments agree in giving a value of λ 2555 ± 20 Å.U. for the photoelectric threshold of potassium vapour. The energy of dissociation is found to be $0\cdot50_5 \pm \cdot01$ volt, the corresponding heat of dissociation being 11·400 calories. In the range of temperature (200° C. to 500° C.) generally used in experiments on potassium vapour, the fraction associated varies from 10^{-4} to 10^{-2}. [See also Abstract 1265 (1928).] A. B. W.

2478. Space Distribution of Photoelectrons Ejected by X-Rays. E. C. Watson. *Phys. Rev.* 31. *pp.* 728–741, *May*, 1928.

Reviews the experimental work on the subject and attempts to show that previous theories of the space distribution do not agree perfectly with the experimental evidence. Calculates by means of Rutherford's theory of nuclear scattering what the distribution would be if all the electrons were ejected from their atoms in the direction of the electric vector of the X-ray and then scattered by the surrounding atoms. All the details can be satisfactorily explained in this way; the dependence of the amount of the spread on the nature of the atoms from which the electrons start and on the frequency of the ejecting X-rays; the amount of the spread; the form of the distribution curves; the difference between the lateral and longitudinal distributions. The scattering of 17 kV electrons by hydrogen nuclei is many times greater than can be accounted for on the classical theory. Scattering in getting out of the parent atom is also considered, and the author points out that it is quite possible that some of the scattering may take place when the electron is first ejected.

H. N. A.

2479. Rôle of the Positive Ions in the Spontaneous Discharge in Air. W. Müller. *Zeits. f. Phys.* 48. 9–10. *pp.* 624–646, 1928.

The question considered is whether the positive ion of small velocity, occurring in discharges at higher pressures, participates in the discharge process by the production of ions by collision (as do the electrons) or by liberation of electrons at the kathode. By investigating the effects of widely varying conditions on the discharge (induced by means of a radium preparation) between two coaxial cylinders at a potential difference in the neighbourhood of the breakdown potential, and also by working with brief discharges at potential differences higher than the breakdown potential, it is shown that the positive ions act by freeing electrons at the kathode. W. S. S.

2480. Positive Ray Analysis of Water Vapour Ionised by Impact of Slow Electrons. H. A. Barton and J. H. Bartlett, Jr. *Phys. Rev.* 31. *pp.* 822–826, *May*, 1928.

An electromagnetic method of separating gas ions of different mass, such as that used by Dempster, has been employed in a study of the ions produced by electron impact in water vapour. The principal ions appearing were $(H_2O)^+$ and $(OH)^+$. Of these the $(H_2O)^+$ ions were more abundant. Unmistakable evidence was obtained that a third type of ion, probably $(H_3O)^+$, was produced in very small quantities. H^+ and H_2^+ ions were always very few in number or unobservable. No $(OH)^-$ or any other negative ions were observed. The ionisation potential corresponding to $(H_2O)^+$ was $13 \pm 1 \cdot 5$ volts, being probably in agreement with the ordinarily measured ionisation potential. The $(OH)^+$ ionisation potential was not distinguishably different, but it was difficult to measure this quantity owing to some overlapping of the $(H_2O)^+$ and $(OH)^+$ peaks. A study was made of the variation in the relative abundance of the ions as a function of pressure. The $(H_2O)^+$ ion appears to be the primary ion, as it predominates at low pressures, but is of the same order of magnitude as the $(OH)^+$ ion at high pressures (0·007 mm.). AUTHORS.

2481. Mercury Lamp and Radium as Ionisers. Effect on Electric Spark. W. Rogowski and R. Tamm. *Arch. f. Elektrot.* 20. *pp.* 107–114, *May* 11, 1928.

Using a kathode-ray oscillograph [see Abstract 181 (1928)] and apparatus similar to that previously employed [Abstract 1679 (1928)] an investigation was made of the effect of the light from a mercury lamp and of the radiation from radium on the potential required to produce a spark between metal electrodes in air. It is shown that the mercury lamp used produced about the same effect as 7 mgm. of radium, both being about 10 cm. from the spark gap. A. W.

2482. Predicted Ionisation Potential of Niton. S. C. Biswas. *Phil. Mag.* 5. *pp.* 1094–1098, *May*, 1928.

The ionisation potential I of an element is given by the equation $I_{(volts)} = (k \,.\, n/r^2) \times 3\cdot 83$, where n and k are the radial and azimuthal quantum numbers respectively, and r^2 is the mean square radius of the (n, k) orbit. Since k is the same for elements of the same family, the ionisation potentials of elements of the same family are inversely porportional to r^2 and directly porportional to n. The atomic radii of the rare gases are calculated from their ionisation potentials, and the values compared with those calculated from crystal data, from viscosity measurements, and from van der Waals' "b." Although the values found by different methods do not agree, there is in general a parallelism between the different series. By extrapolation, the atomic radius of niton is given as $1\cdot 81 \pm \cdot 03$ Å., whence the calculated ionisation potential is $14\cdot 0 \pm 0\cdot 5$ volts.

L. L. B.

2483. Ionisation in Positive Ion Sheaths. P. M. Morse and W. Uyterhoeven. *Phys. Rev.* 31. *pp.* 827–832, *May*, 1928.

It was found that the positive ion current to a plane auxiliary collector placed in a neon discharge had about twice the value expected from the equations of Langmuir and Mott-Smith. This increase must be due to an ionisation within the sheath surrounding the electrode or to an emission of electrons from the surface of the electrode. Four different possible causes of the increase are analysed, and relations between the voltage drop V, the total current to the collector i and the sheath thickness x are obtained. Comparison with data shows that the increase in i is probably caused by the ionisation of the metastable atoms within the sheath by radiation from the discharge. The relations $V = A(Bx^{4/3} \times Cx^{8/3})$ and $i = i_0 + I_0 x^2/2$ hold, and check fairly well with the three experimental curves. Considerations of atomic energy states of the metastable atoms show that this ionisation would be most marked in the noble gases, and almost non-existent in mercury vapour, which was the gas investigated by Langmuir and Mott-Smith.

AUTHORS.

2484. Field Currents from Points. C. F. Eyring, S. S. Mackeown and R. A. Millikan. *Phys. Rev.* 31. *pp.* 900–909, *May*, 1928.

The laws governing the extraction of electrons from metals in high vacua by fields, first developed through experiments with crossed wires, then with fine wire kathodes discharging to cylindrical anodes, have been now found to hold throughout for field currents between points and planes. The theory needed for the quantitative determination of the potential gradients at points is here given, and critical gradients are then determined experimentally. The generality of the linear relation between log i and the reciprocal of the field-strength is experimentally established.

AUTHORS.

2485. Multiple Positively Charged Radioactive Ions. L. B. Loeb. *Science*, 67. *pp.* 468–470, *May* 4, 1928.

In a previous paper [see Abstract 426 (1928)] it was shown that there is practically no evidence for the existence of doubly charged positive ions in gases for intervals of time usually involved in gas ion mobility measurements. There remains unexplained a definite observation of Erikson's [see Abstract 763 (1926)] on the mobility of recoil atoms from active deposits of radium, thorium and actinium. Erikson found positive ions of mobility 1·56 for these recoil atoms, which are doubtless the normal singly charged positive ions in air. He also found in high fields with shorter time intervals, simultaneously with the slower ions, ions of mobility 4·35 cm./sec. per volt/cm. in each case. These apparently do not show the ageing effects usually found for positive ions in other gases. Reasons are here given for believing that in this case we may be dealing with a multiply charged ion of charge at least three or greater. A. W.

2486. Regenerative Receivers. G. Ostroumoff. *Ann. d. Physik.* 85. 8. *pp.* 1103–1112, *May* 24, 1928.

A number of experiments with receivers of the regenerative type are described bearing on the question of the energy distribution between transmitter and receiver. A. W.

2487. "Kipp" Oscillations. E. Friedländer. *Arch. f. Elektrot.* 20. *pp.* 158–161, *June* 7, 1928.

A further discussion of "kipp" oscillations with reference to van der Pol's work on relaxation oscillations. [See also Abstracts 455 and 576 B (1927).] A. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2488. Mechanical Influences affecting the Electrical Conductivity of Metals. A. Michels. *Ann. d. Physik,* 85. 6. *pp.* 770–780, *April* 17, 1928.

Recent researches on the influence of mechanical work on the electric conductivity of metals are reviewed, various papers published during the last three years being briefly considered. Investigations by the author on the effect of hydrostatic pressure on the electric resistance are not in agreement with any of the hitherto published theories, and he in this paper seeks to furnish a contribution to the theory of the subject. Loading (1) below and (2) beyond the limits of elasticity are considered. If a metal wire (one of crystalline structure is alone considered) undergoes unilateral stretching the conductivity falls approximately proportionally to the loading. On the transversal effect views differ. So long as the actual mechanism of electric conduction is uncertain it is difficult to assert what occurs, but the author attempts to reconcile with each other the various results so far obtained. The influences may probably be placed under three different divisions: (1) deformation with stretching, (2) scalar compression, (3) eventually with diminution of the grain. The author hopes to publish further results. J. J. S.

2489. Elementary Theory of the Magnetic and Electric Properties of Metals at the Absolute Zero of Temperature. J. Frenkel. *Zeits. f. Phys.* 49. 1–2. *pp.* 31–45, 1928.

Makes use of the methods employed in a previous paper on metallic conductivity [see Abstract 1972 (1928)]. When there are no magnetic or electrical forces all the electrons are united in magnetic pairs, which neutralise one another magnetically, in those phase cells which correspond to minimum energy, and these phase cells can be regarded as a combination of the total volume of the metal, V, with concentric spherical shells in the impulse space. In a weak magnetic field the outer electron pairs split up, first the outermost pair in the Z_0 shell, one electron remaining in this shell and the other going to the $Z_0 + 1$ shell outside it, then for a somewhat larger field an electron passes from the (Z − 1) shell to the (Z + 2) shell, and so on; the singleton electrons set themselves with their magnetic axis parallel to the field. In this way the author arrives at an expression for the portion of the magnetic susceptibility independent of the temperature, which agrees with that of Pauli. The calculations being made for the absolute zero, the Pauli-Fermi statistical method is replaced by a quasi-statistical one. The nature of ferromagnetism is considered qualitatively; the exit work of the metal electrons is calculated, using the virial law; the Volta potential difference between two different metals is deduced in a simple manner; and the density and compressibility are theoretically determined by introducing the kinetic energy as energy of repulsion. H. N. A.

2490. Theory of Electric Breakdown. Part I. P. Böning. *Arch. f. Elektrot.* 22. *pp.* 88–98, *May* 11, 1928.

The formulæ proposed by Steinmetz, Baur, Grünewald, Schumann and others for the relation between electric breakdown voltage and thickness of dielectric are collected together and discussed briefly with reference to experimental results. Theory is then developed, based on space charge effects, leading to formulæ for the potential distribution function for the case of plane electrodes. Assuming the electric strength of a dielectric is a constant of the material a formula is then deduced for the electric breakdown function for the case of plane parallel electrodes. Results calculated from this formula are shown to be in very close agreement with values found experimentally for various dielectrics. The corresponding function for the case of spherical electrodes is also derived and again the calculated results agree closely with experiment. A polarity effect is found with unsymmetrical electrodes and the formula given satisfactorily accounts for this. A. W.

2491. Dielectric Constant of Solutions of NaCl. A. Bramley. *Frank. Inst., J.* 205. *pp.* 649–657, *May*, 1928.

Let D be the dielectric constant of the solution, η the concentration, and D_0 (= 81·0) the dielectric constant of pure water; then $D^2 = D_0^2(1 - 15\cdot7\eta)$, or, for small concentrations, $D = D_0(1 - 7\cdot85\eta)$.

A. D.

2492. Dielectric Constant of Benzile. L. Saint-Antoine. *Comptes Rendus*, 186. *pp.* 1429–1431, *May* 21, 1928.

R. de Mallemann [see Abstract 316 (1928)] has shown that benzile, $C^3H^5 . CO . CO . C^6H^5$, has remarkable electro-optic properties. It was desirable to know the dielectric constant. This is for $c = 10\cdot6$, $k = 3\cdot37$ at 5°, 3·34 at 15°, 3·28 at 35°; for $c = 20$, $k = 4\cdot17$ at 5°, 4·13 at 15°, 4·05 at 35°; for melted benzile, $k = 13\cdot04$ at 95°, 12·54 at 110°, 12·12 at 120°. A. D.

2493. Electric Moments and Spatial Atomic Arrangements of some Para Derivatives of Benzene. J. W. Williams. *Phys. Zeits.* 29. *pp.* 271–272, *May* 1, 1928.

In an earlier publication [see Abstract 1703 (1928)] it appeared from measurements with *p*-xylene and *p*-dinitrobenzene that para derivatives with two like substituents would not exhibit an electric moment. Data now described for solutions of hydroquinone diethyl ether and hydroquinone diacetate show that both these substances exhibit considerable polarity and indicate a non-coplanar structure for the groups and the benzene ring. The results are discussed in connection with Ebert and v. Hartel's work [see Abstract 532 (1928)], on substances of the type $C\alpha_4$, where α may be H, Cl, CH_2Cl, CH_2Br, NO_2, OCH_3, OC_2H_5, $CH_2O_2CCH_3$. Electrical dissymmetry first appears when the substituent groups exceed a limiting length or complexity. H. H. Ho.

2494. Dipole Moments of Symmetrical Compounds and the Cis-Trans-Isomerism of Simple Bonds. A. Weissberger. *Phys. Zeits.* 29. *pp.* 272–273, *May* 1, 1928.

Some stereochemical conclusions are drawn with respect to the dipole moments of symmetrical compounds and the cis-trans-isomerism of simple bonds. Explanations are included for the isomeric yellow and colourless substituted benzils on grounds of cis-trans-isomerism rather than the accepted diketone-superoxide constitutional basis, and for the existence of a considerable dipole moment for symmetrical trinitro-benzene. [See preceding Abstract.] H. H. Ho.

2495. New Type of Selenium Cell. R. E. Martin. *J.O.S.A. and R.S.I.* 16. *pp.* 279–281, *April*, 1928.

A description is given of the manufacture of a special form of cell in which cylindrical pieces of selenium of small cross-sectional area were required. Particulars of the annealing process are also given. The resulting cells were permanent, of high sensitivity, of high resistance and positive. Their dark resistance was of the order of 5×10^5 ohms and their light sensitivity for all cells was 40 % and for some cells 75 %. Some cells had their electrodes fixed on before annealing and some after. No difference in their performance could be detected, hence it is assumed that the selenides formed do not affect the properties of the cells. F. R. C. R.

2496. Further Uses for the Neon Grid-Glow Tube. T. R. Wilkins and F. B. Friend. *J.O.S.A. and R.S.I.* 16. *pp.* 370–373, *May*, 1928.

Two applications of the three-electrode neon tube are described. The first shows how the neon tube can be used for the registration of α-rays. One electrode of an ionisation chamber is connected to the grid of the neon tube and the tube flashes on the entrance of each α-ray. In the second device the tube is arranged to flash periodically, and it is found that under certain critical conditions a bias potential of a volt or two has a marked and easily measurable effect on the periodicity of discharge. AUTHORS.

ALTERNATING CURRENTS AND MAGNETISM.

2497. Method of Maintaining a Constant R.M.S. Value of an Alternating Voltage. Soulié. *Comptes Rendus*, 186. *pp.* 1528–1530, *June* 4, 1928.

An iron-cored solenoid in series with a condenser across an alternating current supply can be designed to give a constant r.m.s. value of the voltage across the condenser. This paper gives a brief description of the design of such a solenoid, and of the preliminary results obtained. By connecting a suitable transformer across the terminals of the condenser, the output from the transformer can be used to supply the filament current for a Coolidge tube, with improved results. R. C. F.

2498. Magnetisation of Single Crystals of Iron at High Temperatures. K. Honda, H. Masumoto and S. Kaya. *Tohoku Univ., Sci. Reports,* 17. *pp.* 111–130, *March,* 1928. *In English. Report No.* 182 *from the Research Inst. for Iron, Steel and other Metals.*

The magnetisation of single crystals of iron has been studied at ordinary temperatures [see Abstract 1888 (1927)] and the study is here extended to determine the effect of temperature. The material is tested in the form of a rod and of an ellipsoid. In the rod the magnetisation at ordinary temperature increases uniformly up to I = 1000, and thereafter shows two sharp breaks before reaching its saturation value 1707. The effect of temperature displaces the breaks towards lower fields, and lowers the saturation value till it vanishes at 790° C. The saturation value at absolute zero is estimated at 1752. The relations between magnetisation and temperature are similar for the three principal axes, and are also similar to those for the iron rod. G. E. A.

2499. Magnetism and the Structure of some Simple and Complex Molecules. D. M. Bose. *Phil. Mag.* 5. *pp.* 1048–1067, *May,* 1928.

Makes use of the author's theory of paramagnetism, which differs from that of Hund in assuming that only the spin moments of the electrons contribute to the magnetic moment of the ion—*i.e.* $\bar{l} = 0, j = s, g = 2$—and calculates the magnetic moments, n_w, in Weiss magnetons of the different ions of the elements of the first transition group; these are compared with the values of n_w for the fourfold coordination compounds of these elements obtained by Ray and Bhar, and the results are discussed in terms of Sidgwick's theory of the nature of coordination links. It is concluded that if in a sixfold compound there are four vacancies in the M_3 shell of the central atom, four of the twelve shared electrons occupy this shell, and eight form an octet shell round the core. If some of the four electrons cannot be accommodated they move in orbits outside the octet shell. The effects of atomic groups, such as OH, OH_2, NH_3, which take part in coordination compounds are considered. H. N. A.

2500. Magnetostriction Oscillators. G. W. Pierce. *Am. Acad., Proc.* 63. 1. *pp.* 1–47, *April,* 1928.

A description is given of a new method of using magnetostriction to produce and control electrical and mechanical frequencies of oscillations in a range of frequencies extending from a few hundred p.p.s. to more than three hundred thousand. The method involves the interaction of the mechanical vibrations of a magnetostrictive rod and the electric oscillations of an electric circuit in such a way that the electric currents in the circuit stimulate the rod to longitudinal vibration by magnetostriction, and the vibrations of the rod react by magnetostriction on the electric circuit to maintain constancy of frequency. The constancy of frequency obtained compares favourably with that obtained with the piezoelectric crystal oscillators. For ease of construction and operation the magnetostriction oscillator has a great advantage over the piezoelectric oscillator, particularly in that the construction and adjustment of the magnetostriction vibrators is so simple that large numbers of standards of frequencies all operable with the same electrical circuits may be had at small expense. The paper contains also methods for calibrating the

vibrators and for their use in the calibration of wavemeters and frequency meters, data on the velocity of sound in various metallic alloys, data on the elastic constants of metals, including their temperature coefficients, description of methods of sound production, and a theoretical investigation of sound propagation in a viscous magnetostrictive medium.
A. B. W.

2501. Method for the Direct Experimental Determination of the Magnetic Moment of a Single Electron. T. Sexl. *Zeits. f. Phys.* 48. 9–10. *pp.* 729–730, 1928.

The method is essentially analogous to the Millikan experiment except that the small drop or particle is presumed to be unmagnetisable and to attain its limiting velocity under the action of gravity together with the magnetic force on its captive electron due to a suitably arranged non-homogeneous magnetic field. It is suggested that a solution of a paramagnetic salt in water which is diamagnetic might serve as the unmagnetisable substance constituting the droplets. W. S. S.

2502. Variation of Magnetic Elements. C. Chree. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 1. *pp.* 532–541, *March,* 1928.

La Cour's corrections for secular change in the magnetic elements for the epoch 1911–1920 are discussed in relation to the special conditions obtaining at the observatories of Kew and Eskdalemuir. W. A. R.

2503. Oscillations of Terrestrial Magnetism and Electricity and Solar Effects. A. Nodon. *Comptes Rendus,* 182. *pp.* 942–944, *April* 2, 1928.

Observations of the magnetic and electric fields show that rapid oscillations lasting about seven seconds occur during the formation of diametral centres of solar disturbance. The propagation of radio waves is tentatively stated to be simultaneously affected. A. Wh.

2504. Summary of Magnetic-Survey Work by the Carnegie Institution of Washington, 1905-1926. J. A. Fleming and H. W. Fisk. *Terr. Mag.* 33. *pp.* 27–36, *March,* 1928.

2505. Magnetic and Electric Observations of the "Maud" Expedition during 1918 to 1925. J. A. Fleming and H. W. Fisk. *Terr. Mag.* 33. *pp.* 37–43, *March,* 1928.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

2506. Comparison of the Parameters of Muscular Excitability by Microscopic Examination of the Response. P. Fabre. *Comptes Rendus,* 186. *pp.* 1150–1152, *April* 23, 1928.

The preparation of a frog's gastrocnemius muscle to allow microscopic observation of a small bundle of its muscle fibres is described in detail. The chronaxy [see Abstract 2147 (1927)] is discussed, and it is found the action of curare is twofold, namely, in causing variation of the conduction of the excitation and in causing tissue death. The effect of temperature upon the preparation is also found to conform to a law previously determined by the author [see Abstract 744 (1928)]. B. J. L.

2507. Physical Basis of Light Therapy. F. L. Hopwood. *Nature*, 121. *pp*. 625–630, *April* 21, 1928. *Supplement. Reprint from St. Barts. Hospital Gazette.*

Gives a general review of the physics of ultra-violet radiation and methods of measuring the quality and quantity. B. J. L.

2508. Biological Action of Ultra-Violet Rays. L. Hill. *Nature*, 121. *pp*. 630–633, *April* 21, 1928. *Supplement.*

Describes the biological reactions induced by ultra-violet with special reference to the effect upon pathological conditions as rickets, osteomalacia, tuberculosis, etc. The author states there are no grounds to believe there is any specific effect as regards wave-length of radiation. B. J. L.

2509. Physiological Action of Ultra-Violet Radiation and its Use in the Home. W. K. Russell. *Nature*, 121. *pp*. 633–636, *April* 21, 1928. *Supplement.*

A general account of the medical uses of ultra-violet radiation. The installation of ultra-violet lamps in the home is also discussed, and recommendations for installing them are given. B. J. L.

2510. Ultra-Violet Radiation for Domestic Use. S. Russ. *Nature*, 121. *pp*. 636–638, *April* 21, 1928. *Supplement.*

The installation of artificial sunlight apparatus in the home is discussed. The dangers are pointed out, and in general the author is opposed to such installations. B. J. L.

2511. Medical Aspects of "Artificial Sunlight" in Private Houses. P. R. Peacock. *Nature*, 121. *pp*. 638–639, *April* 21, 1928. *Supplement.*

The dangers of the use of ultra-violet lamps in the home without medical supervision are stressed. It is concluded that such lamps should only be utilised in properly equipped clinics under medical supervision. B. J. L.

2512. Lamps for Light-Baths. T. C. Angus. *Nature*, 121. *pp*. 639–641, *April* 21, 1928. *Supplement.*

The relative advantages and disadvantages of mercury vapour and open-arc ultra-violet generators are discussed, and precautions to be taken in their use are briefly reviewed. B. J. L.

2513. Selection of Ultra-Violet Lamps for Home Use. B. D. H. Watters. *Nature*, 121. *pp*. 641–643, *April* 21, 1928. *Supplement.*

Descriptions of commercial lamps are given. The lamps described are restricted to advertisers. Precautions in their uses are briefly discussed. B. J. L.

2514. Ultra-Violet Transmission of Transparent Materials. L. C. Martin. *Nature*, 121. *pp*. 643–644, *April* 21, 1928. *Supplement.*

The transparency of various media to ultra-violet radiation is discussed. Such media are crystalline and fused quartz, Jena glass, Lamploughs glass. Their chemical composition and durability are briefly mentioned, and the subject is considered from a spectrometric aspect. B. J. L.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

2515. Theory of Adsorption. T. Sexl. *Zeits. f. Phys.* 48. 9–10. *pp.* 607–610, 1928.

On the basis of statistical considerations, analogous to those employed by Stern [see C. Schaefer, *Theoretische Physik*, II, p. 542 *et seq.*, 1921] in arriving at the vapour pressure formula, a formula for the absorption of gases at solids is deduced and found to agree in structure with the Langmuir formula. The phenomenological constants of the latter formula thus acquire molecular-kinetic significance. T. H. P.

2516. Adsorption Equation. M. N. Chakravarti and N. R. Dhar. *Kolloid Zeits.* 45. *pp.* 12–21, *May*, 1928.

The equation given in a previous paper [see Abstract 1065 (1928)] is applied under the assumption that in non-polar adsorption each molecule occupies unit elementary space, so that n (the number of cavities required by the adsorbed substance) has the value 1, whilst in polar adsorption n will in general be equal to the valency of the adsorbed ion. The value of K should remain constant as long as the same surface is used; but the nature of the adsorption must also be the same, since the active points of the surface will not be equally active for different ions and molecules. Taking the data of various experimenters the authors find that the adsorption relations are better expressed by their equation than by others. This applies to the adsorption of silver salts by precipitated silver iodide (Beekley and Taylor); absorption of arsenic ion by iron hydroxide (Sen); of acetic acid, iodine in several solvents and various salts by charcoal, and salts of different valencies by charcoal and by barium sulphate (Ghosh and Dhar, Kammer and Silvermann, Odén and Anderson). The adsorbed layer cannot be more than one molecule in thickness. There are maxima of adsorption A, as was to be expected. The values of K and of a (the fraction of the molecules hitting the surface retained by it) should only depend upon the chemical nature of the adsorbent, but be independent of the method of preparation and of age, whilst A, depending upon the number of active points, should be influenced by age and the method of preparation. H. B.

2517. Diffusion of Hydrogen through Iron. W. E. Deming. *Phil. Mag.* 5. *pp.* 1081–1084, *May*, 1928.

The amount m of hydrogen passing through a metal slab of thickness x in time t, with gas pressures P_1 and P_2 on the sides of the slab, may be given either by (1) $m = K_1At[(P_2^{1/n} - P_1^{1/n})/x^{a_1}]$ or (2) $m = K_2At[(P_2 - P_1)^{1/n}/x^{a_2}]$. It is proved that a_1 must be unity and a_2 must be $1/n$, so that experiments on the effect of variation of x on the rate of diffusion would lead to a decision between (1) and (2). The fact that Lombard found $m \propto x^{-1}$ [see Abstract 2629 (1927)] decides in favour of $m \propto (P_2^{1/n} - P_1^{1/n})$, rather than $m \propto (P_2 - P_1)^{1/n}$. L. L. B.

2518. Sedimentation Period of Small Particles in a Liquid. W. Weaver. *Zeits. f. Phys.* 49. 3–4. *pp.* 311–314, 1928.

This paper continues previous work [see Abstract 2800 (1927)] and supplements Fürth's investigations [see Abstracts 1560 (1927) and 198 (1928)] by again discussing the upper limits of the sedimentation period of small particles. The formula previously obtained (*loc. cit.*) is now confirmed. H. H. Ho.

2519. Influence of Relative Ionic Sizes on the Properties of Ionic Compounds. L. Pauling. *Am. Chem. Soc., J.* 50. *pp.* 1036–1045, *April*, 1928.

A method of calculating the mutual energy of ions in terms of standard ion ionic radii was developed from the simple method of Born. It was shown that the ratio of the cation radius to anion radius influences the properties of ionic substances. Irregularities in interionic distances, melting points and boiling points of the halides of the alkali metals were explained as a result of this effect. F. J. B.

2520. Soaps as Colloidal Electrolytes. J. W. McBain. *Am. Chem. Soc., J.* 50. *pp.* 1636–1640, *June*, 1928.

An attempt was made to describe soap solutions on the basis of dissociation into simple monovalent ions only, instead of colloidal micelles. It was found that such a description cannot be carried out without ignoring the ascertained facts of ultra-filtration, migration, viscosity and conductivity. The ionic micelle was shown to be an exception to the rule of ionic strength, on account of the large distance between the charges carried on a single ionic micelle, in contrast to the proximity of the charges on an ordinary polyvalent ion. F. J. B.

2521. Some Physical Properties of Acetic Anhydride and Related Substances and their Constitutional Significance. D. C. Jones. *Chem. Soc., J. pp.* 1193–1200, *May*, 1928.

In dilute solutions in cyclohexane or benzene, acetic anhydride gives normal freezing-point depressions. In the former solvent, the molecular weight of the anhydride increases rapidly with the concentration, this behaviour probably illustrating merely the positive deviation of the system from Raoult's law, since the two liquids form a two-liquid layer system. The temperature coefficients of molecular cohesion and of molecular surface energy, as determined by Walden and Swinne [*Zeits. f. phys. Chem.* 82. p. 296, 1913] for acetic anhydride and acid, carbon disulphide, aniline, and hexane support the view that acetic anhydride and aniline behave as normal liquids, whereas acetic acid gives only about one-half of the calculated values; hexane and carbon disulphide are typical normal liquids. Sidgwick (*Electronic Theory of Valency*, p. 137) suggests that it is the absence of coordinating hydrogen which accounts for the fact that ethyl ether, as judged by its properties in the pure state, is unassociated, as contrasted with ethyl alcohol; acetic anhydride probably affords another instance of this, there being no acceptor atom present. Other questions considered are: the parachor and the constitutions of acetic acid, acetic anhydride, and ethyl alcohol; the solubility of some C_4 compounds in saturated hydrocarbons, and the effect of oxygen-containing groups on the solubility in water of C_4 oliphatic compounds. T. H. P.

2522. Thermochemical Contribution to the Study of the System Cadmium Mercury. T. W. Richards, H. L. Frevert and C. E. Teeter, Jr. *Am. Chem. Soc., J.* 50. *pp.* 1293–1302, *May*, 1928.

It is pointed out that many investigations have been carried out on cadmium amalgams because these substances are used in the Weston standard cell. Though earlier workers, using mainly analytical methods, thought they had discovered a number of compounds of cadmium and mercury, later workers (especially Bijl), using chiefly the analysis of cooling curves, decided that only mix-crystals, or solid solutions, exist. From other lines of evidence, however, it seemed possible that one compound of cadmium and mercury exists. The present research was begun in 1906, and refers to the heats of solution of cadmium amalgams in mercury. The large amount of heat absorbed on dissolving various cadmium amalgams in mercury are given. It is found that this heat is of the order of magnitude of the latent heat of melting of cadmium and mercury, though somewhat larger. Its magnitude indicates clearly whether or not the amalgam is fully solid or contains included liquid mercury, and it is therefore one of the best means of locating the exact solidus point, the point at which liquid first appears when the solid is fully homogeneous. The results of the investigation are consistent with the researches of Bijl and of Smith between 20° and 30°. J. K.

2523. Has Aluminium a Transformation Point? A. Schulze. *Zeits. f. Phys.* 49. 1–2. *pp.* 146–154, 1928. *From the Reichsanstalt.*

Various experimenters have produced evidence tending to show in various ways that aluminium, when heated, undergoes an allotropic modification, while others ascribe the observed effects to impurities in the material used. The author has measured the electric resistance of aluminium of different degrees of purity, the purest specimen containing 99·94 % of Al, and finds that in the pure material there is no transformation point up to 610° C. He is of opinion that the thermal expansion is not a suitable magnitude to employ in this case in the investigation of the constitution of the material. H. N. A.

2524. Region of Existence of Unimolecular Reactions. L. S. Kassel. *Am. Chem. Soc., J.* 50. *pp.* 1344–1352, *May*, 1928.

The typical homogeneous gaseous decomposition passes through three stages: at high pressures it is of the second order, due to reaction occurring at collisions; at lower pressures the reaction becomes of the first order, the dominant factor being spontaneous decomposition of activated molecules, which are produced by collisions rapidly enough to maintain essentially the Maxwell-Boltzmann quota; at rather low pressures the reaction is again of the second order, although the velocity constant is higher than for the high-pressure phase. In this third stage nearly all of the activated molecules decompose, since collisions, which would cause de-activation, have now become infrequent. The decomposition of acetaldehyde furnishes an example of a reaction in the process of transition from the high-pressure bimolecular stage to the unimolecular stage, whilst the decomposition of azomethane indicates the transition from unimolecular to low-pressure bimolecular. Several possible types of bimolecular reactions exist, and in some cases it may be possible to decide which of them is in question. In general, all of the types proceed together, but one of them may account for all but a negligible fraction of the total reaction. The formula proposed by Dushman [see Abstract 1869 (1921)] for the velocity of unimolecular reactions is not in agreement with experimental data, the velocities of these reactions having a much greater range of variation than is permitted by the formula. T. H. P.

2525. Equilibrium of Nitrogen and Hydrogen with Ammonia in a Corona Discharge. G. L. Wendt and J. E. Snyder. *Am. Chem. Soc., J.* 50. *pp.* 1288–1292, *May*, 1928.

The equilibrium of ammonia with a 3 : 1 mixture of hydrogen and nitrogen under the action of a corona discharge was investigated. The equilibrium was approached from both sides, starting in one case with pure ammonia and in the other with a 3 : 1 ratio by volume of hydrogen and nitrogen. The establishment of equilibrium was determined by the pressure, which remained constant for several hours, with the discharge passing through the mixture of gases. It was found that at a pressure of 733 mm. of mercury and a temperature of 28·5° C., 4·1 % of ammonia by volume resulted under the conditions of the experiment. The temperature at which the same equilibrium concentrations would result thermally was calculated, and found to be 270° C. and possibly at a temperature of higher than 2500° C. F. J. B.

2526. Homoiopolarity of the Halogen Hydrogen Molecule. V. Kondratjew. *Zeits. f. Phys.* 48. 7–8. *pp.* 583–585, 1928.

It has been shown that the dissociation energy of a halogen hydrogen molecule may be calculated from its ultra-red vibration spectrum. The numbers thereby obtained agree well with those got from thermochemical considerations. This proves the correctness of the assumed homoiopolar character of those molecules. The views of Franck and Kuhn [see Abstract 93 (1928)] are discussed, and those of Bonhoeffer and Steiner [see Abstract 371 (1927)] and B. Lewis [see Abstract 1759 (1928)]. It appears that the usually homoiopolar gaseous HI molecule on passing into solution is so influenced by the solvent that its binding assumes a typical heteropolar character—that is, the molecule separates in the solution with adiabatic action into two ions. J. J. S.

2527. Electrode Potential of Single Crystals of Iron. K. Iwasé and K. Miyazaki. *Tohoku Univ., Sci. Reports,* 17. *pp.* 163–167, *March,* 1928. *In English. Report No.* 184 *of the Research Inst. for Iron, Steel and Other Metals.*

Measurements of the electrode potential of single crystals of iron and of iron in the usual polycrystal state. The electrodes were immersed in a solution of ferrous ammonium sulphate and the e.m.f. of this cell combined with the calomel normal electrode was measured. The e.m.f. measurements were carried out at 25° C., employing a Leeds and Northrup potentiometer. The results were plotted on a series of time-voltage curves, and they show that the final value in the case of the single crystal is the true value for the potential between iron and its solution. Solution of the iron in the case of the polycrystals caused a rise in the curves, and contamination of the surface brought about a fall. The surface influenced the e.m.f., especially at the commencement of the observations. The behaviour of polycrystal electrodes was the same for fine or coarse-grained structure. F. J. B.

2528. Electrode Potential of Nickel. Part I. Measurements in an Atmosphere of Hydrogen with Reduced Nickel Powder. K. Murata. *Chem. Soc. Japan, Bull.* 3. *pp.* 57–69, *March,* 1928. *In English.*

In view of the lack of agreement in the values obtained in the direct determination of the electrode potential of nickel, the object of this study is to find some means of making a reliable nickel electrode which will give a reproducible, constant and reversible potential. Such is obtained by using powdered nickel reduced with hydrogen directly in the cell and an apparatus which allows the cell to be filled with the electrolyte directly in the absence of air. J. K.

2529. Determination of the ζ-Potential on Cellulose. D. R. Briggs. *J. Phys. Chem.* 32. *pp.* 641–675, *May*, 1928.

The streaming potential method [see Kruyt, Abstract 1443 (1919)] is applied to the determination of ζ for cellulose, the latter being packed tightly into a compartment between two electrodes and a liquid forced through it. Experimental results obtained show that, while the ζ-potential on cellulose is a variable from sample to sample, it may be determined accurately by the streaming potential method, provided that a proper value for the conductivity in the streaming potential equation is obtained. This conclusion carries with it the corollary that the assumptions on which the streaming potential equation is based are accurate and true within experimental error limits. For ζ-potential measurements on cellulose and kindred colloids it is absolutely necessary that foreign ions, especially polyvalent positive ions, should be absent. As approximate values of ζ for two samples of a rag pulp, 0·0214 and 0·0161 volt are obtained, and for a sample of wood pulp, 0·0083 volt. T. H. P.

2530. Study of the Course of a Reaction by Means of Potentiometric Titrations. F. L. Hahn, M. Frommer and R. Schulze. *Zeits. f. phys. Chem.* 133. 5–6. *pp.* 390–396, *April*, 1928.

The investigations described in this paper simplify the titration procedure, extend the application of the method, and study the course of the titration reaction over a considerable interval. Both symmetrical and unsymmetrical titrations are considered. H. H. Ho.

2531. Anomalies of Palladium in its Electromotive Behaviour in Hydrochloric Acid Solution. F. Müller. *Zeits. f. Elektrochem.* 34. *pp.* 237–240, *May*, 1928.

In, for example, the titration of ferrous iron by bichromate following the course of the reaction by the potentiometric method, it would seem that the result according to the equation $\epsilon = \epsilon_0 + 0\cdot058 \log \frac{[\mathrm{Fe}^{\cdot\cdot\cdot}]}{[\mathrm{Fe}^{\cdot\cdot}]}$ should be independent of the indicator electrode employed, but this is not the case. Palladium and platinum give different curves. It is shown, in fact, that the anomalous behaviour of palladium as indicator-electrode in potentiometric investigations on oxidation-reduction reactions, as observed by Hostetter and Roberts, is bound up with the presence of hydrochloric acid. Palladium is also distinguished from the other noble metals by the formation on the electrode of a difficultly soluble coating, the nature of which is so far not known. J. K.

2532. Observations with the Hydrogen Electrode. S. Sekine. *Zeits. f. Elektrochem.* 34. *pp.* 250–253, *May*, 1928.

This paper describes certain experiments with palladium and platinum electrodes which were incorporated separately in an element with a large constant electrode of lead peroxide, these dipping into an electrolyte. Practical details are included in the description. Great differences have been found in the respective behaviours of the palladium and platinum, and although quantitative results have not yet been attained, a tentative explanation is proposed. H. H. Ho.

2533. Calculation of the Electrolytic Dissociation from the Electrolytic Conductivity. W. Nernst. *Preuss. Akad. Wiss. Berlin, Ber.* 1. *pp.* 4–8, 1928.

Having shown [see Abstract 505 (1928)] that the true electrolytic dissociation, apart from the Debye effect of electrostatic reactions of the ions, can be calculated from the temperature coefficients of the heats of dilutions of electrolytes, the author finds that a similar consideration can be applied for estimating, in fair approximation, the degree of association in electrolytes. The degree of association calculated by older formulæ represents the real association and the Debye effect; the latter amounts, for decinormal solutions, to about 0·13. For solutions of 0·005 *N* all the salts discussed (alkalis, silver, thallium) show practically the same ionic mobility, depending mainly upon the Debye effect. At higher concentration association further diminishes the conductivity in most cases, but hardly for KI and for KBr. H. B.

2534. Potential Effect of the Conductivity of Electrolytes in Lower Fields. M. Wien. *Ann. d. Physik,* 85. 7. *pp.* 795–811, *May* 2, 1928.

The author has previously called attention to the deviation from Ohm's law which is shown in electrolyte resistances when subjected to short impacts of current of high tension [see Abstract 2754 (1927)]. The conductivity is dependent on the potential and, indeed, increases with the field strength. This "potential effect" increases rapidly with the valency of the ions. In high fields changes of the conductivity up to over 60 % were observed. Observations show that the potential effect increases approximately with the field. With very high fields the increase is smaller and the conductivity appears to tend to a constant value—the "limiting value." The effect depends on the concentration in that the initial rise of the conductivity is steeper the more dilute the solution is. In very dilute solutions the "limiting value" is already attained with comparatively low fields. With concentrated solutions the rise is slower but lasts longer, so that the limiting value is situated higher than with dilute solutions. The whole stands in close relation with the increase of the equivalent conductivity with the concentration and with the theory of electrolytic conduction put forth lately by Debye and his co-workers. This theory has been extended by Joos and Blumentritt and applied to higher tensions. The comparison between the theory and the author's experimental results shows good qualitative agreement on the whole. The theory indicates an increase of the conductivity proportional to the second power of the field X: $\Delta\lambda_e = AX^2 - BX^4 + C'X^6 - \ldots$, whilst the author's researches show for medium fields an increase proportional to the field. The author's earlier experiments give no conclusion as to the course of the curve in the beginning or its eventual curvature, as the observations in weaker fields were not accurate enough and the null point of the curve could not be fixed. In the present paper an account is given of observations with lower fields which establish the potential effect in this case also with sufficient accuracy and measure it with a series of solutions of varying concentration. The following are the results obtained: (1) The potential effect in weaker fields may be represented for all the solutions investigated by the expression $\Delta\lambda_e = AX^2(1 - BX^2)$, where A and B are constants and X the external field in volt/cm. (2) A is approximately proportional to the square of the product of the valency (Z) of the ions and approximately inversely proportional to the square root of the conductivity. A may be approximately expressed by the formula: $A = 5.5 . Z_1^2 Z_2^2 \sqrt{x_0/x}\, 10^{-13}$, where x_0 is 1/1000 the conductivity. (3) A, besides being dependent on the valency and the conductivity, depends also in a certain degree on the nature of the ions. (4) The second term B increases likewise with the product of the valencies yet much more slowly than A. B decreases with the concentration. (5) With acetone as solvent the course of the phenomenon is the same, but A is greater, B smaller, than in watery solutions under the same circumstances.

J. J. S.

2535. Behaviour of Dilute Electrolytes with High Field Strengths. M. Blumentritt. *Ann. d. Physik*, 85. 7. *pp.* 812–830, *May* 2, 1928.

This is a theoretical paper discussing the results got by Wien in which it appeared that in the case of dilute electrolytes with high field strengths Ohm's law no longer holds, but an increase of the conductivity with the field occurs. Various causes can be assigned as producing this result. Debye's theory of dilute electrolytes furnishes with consideration of the higher approximations an increase of the conductivity with the external field strength according to the formula: $\Delta\lambda = AX^2(1 - BX^2)$. The first term AX^2 gives the increase for small field strengths X. Approximately $A \sim \frac{1}{\sqrt{D\eta}} g(Z)$, whereby for binary electrolytes with ions of equal friction constants $g(Z) = Z^{3 \cdot 5}$ holds. Thus there is got for the initial rise $\Delta\lambda = AX^2$, (1) an increase with decreasing concentration and, indeed, approximately inversely proportional to the square root of the concentration; (2) an increase with decreasing value of the dielectric constant and actually again approximately proportional to the square root of the dielectric constant; (3) a strong increase with the valency of the ions in agreement with the results of Wien's researches. Also the magnitude of the effect is rightly given if electrolytes with ions of varying valencies, as 1–3 and 1–4 valent ions, for which A becomes much too great, are put aside. The next term of the equation whose absolute value was not calculated is given by BX^2 and causes a diminution of the initial rise $A \cdot X^2$. Approximately $B \sim \frac{D}{\eta} f(Z)$ holds, wherein for binary electrolytes with ions of equal friction constants $f(Z) = Z$. B increases with decreasing concentration, as found by Wien. With dielectric constants becoming smaller, B decreases in accordance with the investigations with acetone. Further, theoretically as well as experimentally B has in comparison with A a slower rise with the valency. The great deviations got with the 1-3- and 1-4-valent electrolytes probably indicate that for such the Debye-Hückel theory is not valid. J. J. S.

2536. Electrochemical Behaviour of Silicate Glasses. Part III. M. J. Mulligan, J. B. Ferguson and J. W. Rebbeck. *J. Phys. Chem.* 32. *pp.* 779–784, *May*, 1928.

When an electric current is passed through the walls of a soda-lime glass tube containing mercury as a kathode, a film of gas is formed at the mercury glass interface, which will disappear in time if the direction of the current is reversed. The formation of the bubbles of gas was studied in different glasses at temperatures up to 330° C. The formation of the gas bubbles was observed with a microscope and photographed. New evidence was obtained for the formation and disappearance of the kathode gas during the electrolysis of various glasses and for the permeability of glass to various ions. Anode gas was found to form at temperatures much lower than were previously observed. F. J. B.

2537. Immigration of Ions from Watery Solutions into Glass. F. Quittner. *Ann. d. Physik,* 85. 6. *pp.* 745–769, *April* 17, 1928.

The electrolytic wandering of kations out of solutions of metallic salts in water into certain kinds of Schott's glass was investigated, as also the similar behaviour of H ions out of acid solutions. The temperature was 52° C. and the field strengths varied from about 200,000 to 600,000 volt/cm. The percentage proportion of the conduction due to the immigrating alkali ions relatively to the total current conduction is characteristic of the various kinds of glass and increases with rising concentration of the solutions acting as anode; in many cases it may attain 100 %. In the case of two kinds of glass Ag immigrated more strongly than all the other kinds of ions tested. The divalent ions Ca, Ba, Zn, Cu immigrate, provided that the outgoing masses are very small. The Na immigration from a 10^{-2} normal Na_2SO_4 solution decreases, if the solution is made more acid, linearly with the increasing concentration of H ions. In some cases the process goes on chiefly through wandering H ions. Electromotor behaviour and ionic immigration proceed in a parallel way. In general the research indicates that current conduction in the process considered proceeds either wholly or for the greater part through immigration of H and metal ions; the proportion of the two kinds of ions to the conduction depends on the concentration of the solution and on the kind of glass.

J. J. S.

2538. Present Position of Technical Chromium Plating. A. Siemens. *Zeits. f. Elektrochem.* 34. *pp.* 264–269, *May,* 1928.

The present position of chromium plating on a technical scale is reviewed. The various patents are discussed, and the advantages of the different compositions of the baths are considered. The influence of polarisation and composition of the bath on the quality of the deposit and the current yield are described. The question of analytical control of the bath is considered. The references to the recent literature are collected, as well as references to the important patents, and given in a list. F. J. B.

2539. Electrolytic Solution Forces and the Electrolytic Ionic State. K. Fredenhagen. *Zeits. f. phys. Chem.* 134. *pp.* 33–56, *May,* 1928.

Previous work was continued on the relationship between solubility and solution forces, and between the solution tendency and the ability to form ions [see Abstract 3238 (1927)]. The electrolytic distribution number and the ionic product were calculated for a number of elements. It was found that the distribution numbers did not follow the sequence of the normal potentials of the elements, but large deviations from them were observed. F. J. B.